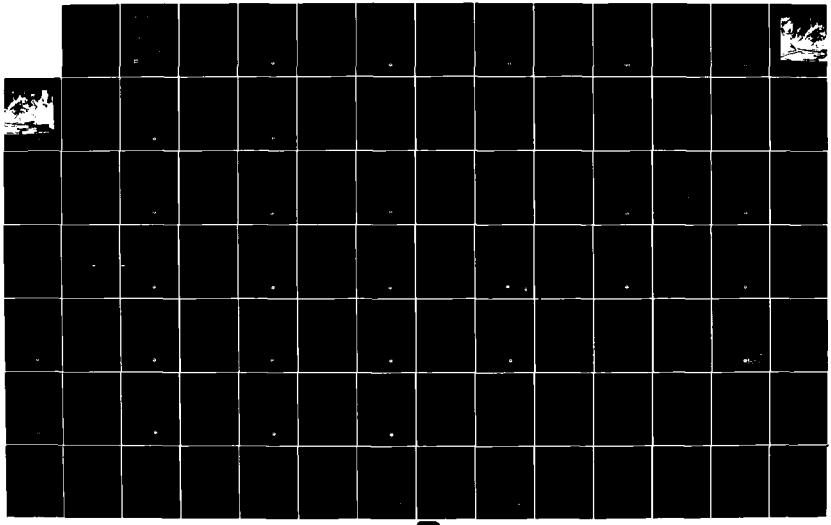
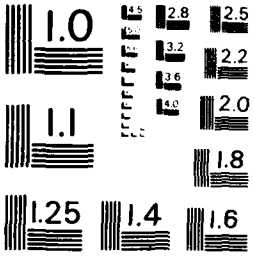
AD-A134 915 CONSTRUCTION FOUNDATION REPORT MISSOURI RIVER FORT PECK LAKE MONTANA VOLUME 3 DRAWINGS(U) CORPS OF ENGINEERS OMAHA NE JAN 83 1/2

UNCLASSIFIED F/G 13/13 NL





CONSTRUCTION FOUNDATION REPORT

(3)

A134915

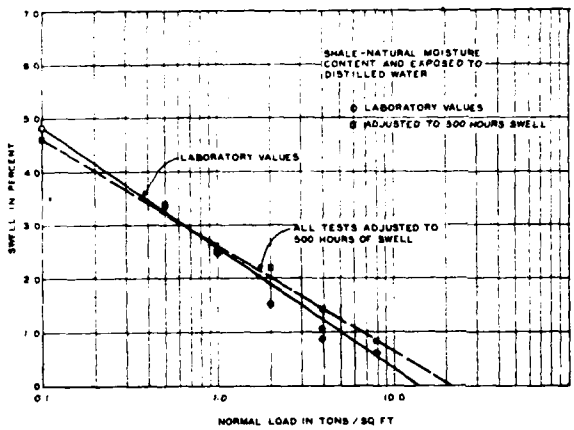
MISSOURI RIVER
FORT PECK LAKE, MONTANA

VOLUME III
DRAWINGS

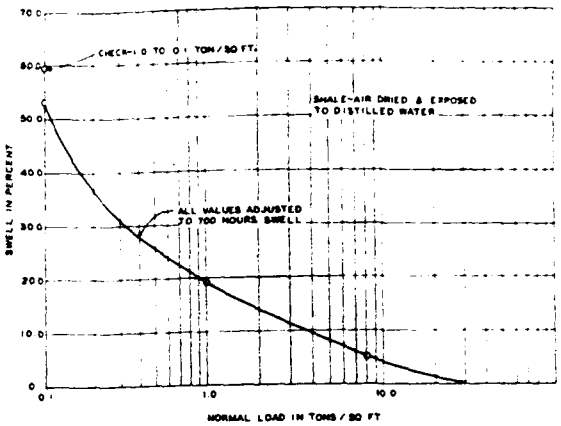
JANUARY 1983

US Army Corps
of Engineers
Omaha District

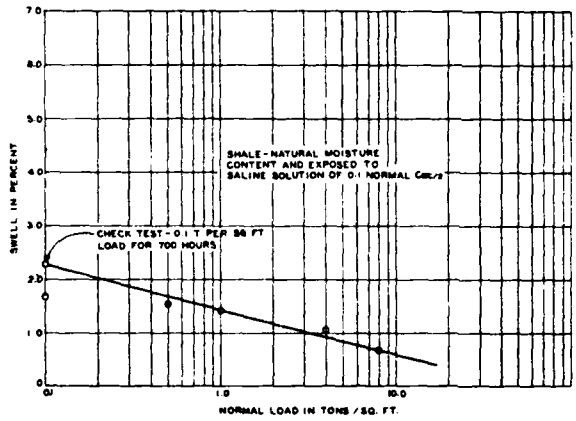
CORPS OF ENGINEERS



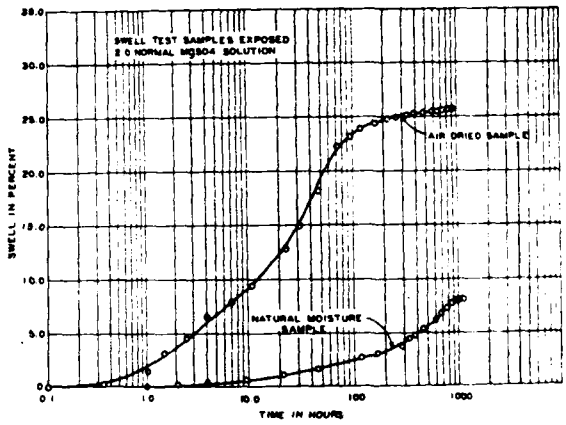
PERCENT SWELL Vs NORMAL LOAD
REPORT SERIES #12 SAMPLES U-13 & U-15



PERCENT SWELL Vs NORMAL LOAD
REPORT SERIES #29 SAMPLE U-23

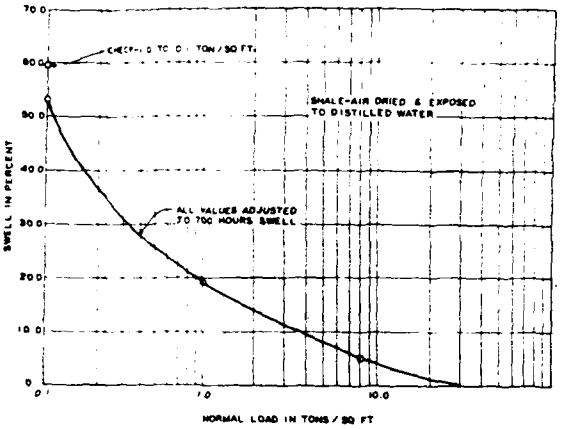


PERCENT SWELL Vs NORMAL LOAD
REPORT SERIES #13 SAMPLE U-15

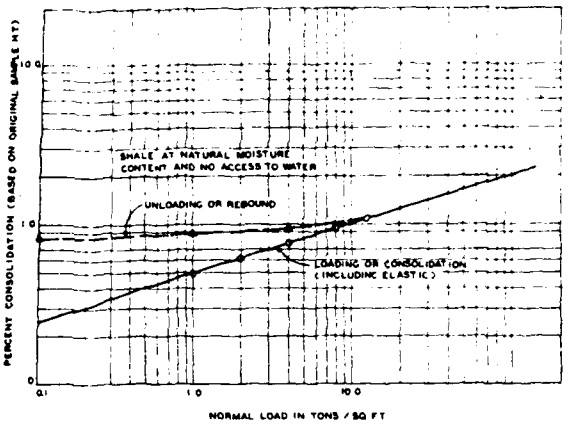


SWELL Vs TIME
0.1 TON PER SQ FT. NORMAL LOAD

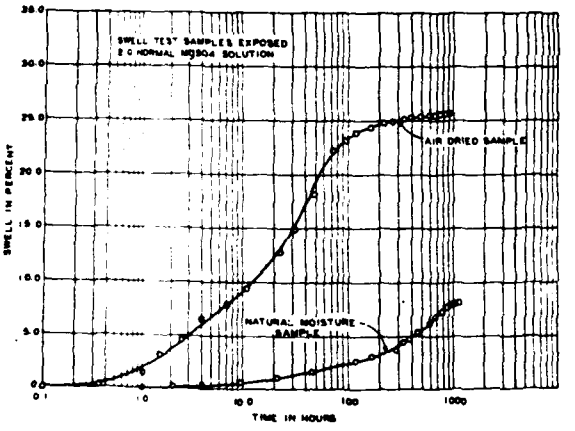
U. S. ARMY



PERCENT SWELL Vs NORMAL LOAD
REPORT SERIES #29 SAMPLE U-23



CONSOLIDATION Vs NORMAL LOAD
REPORT SERIES #1 SAMPLE U-23



SWELL Vs TIME
0.1 TON PER SQ FT. NORMAL LOAD

DTIC COPY INSPECTED 2

A1

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

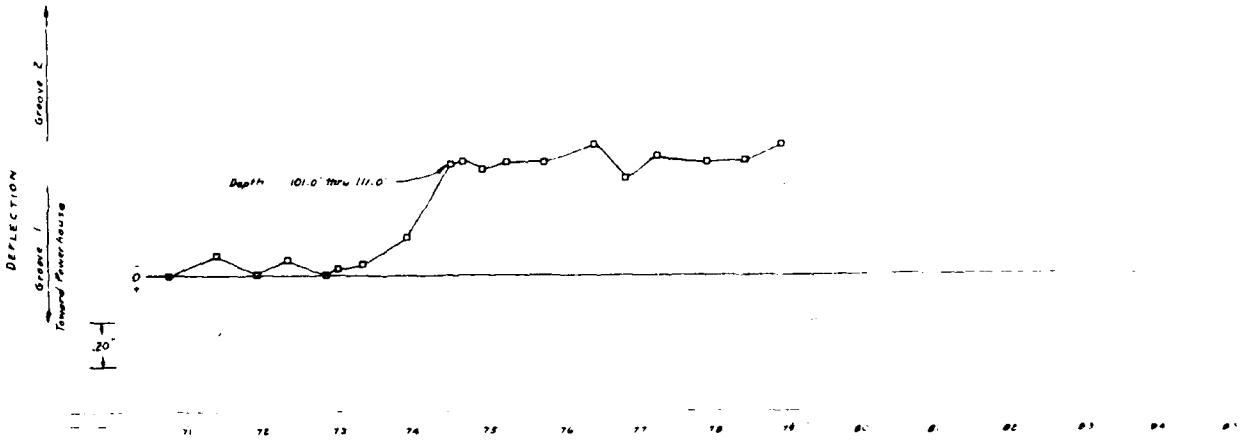
MISSOURI RIVER
FORT PECK DAM AND RESERVOIR
SPILLWAY REHABILITATION
SUMMARY OF RESULTS
SWELL AND CONSOLIDATION TESTS

DRAWN BY: B A
TRACED BY: B A
DATE: SEPT 1966

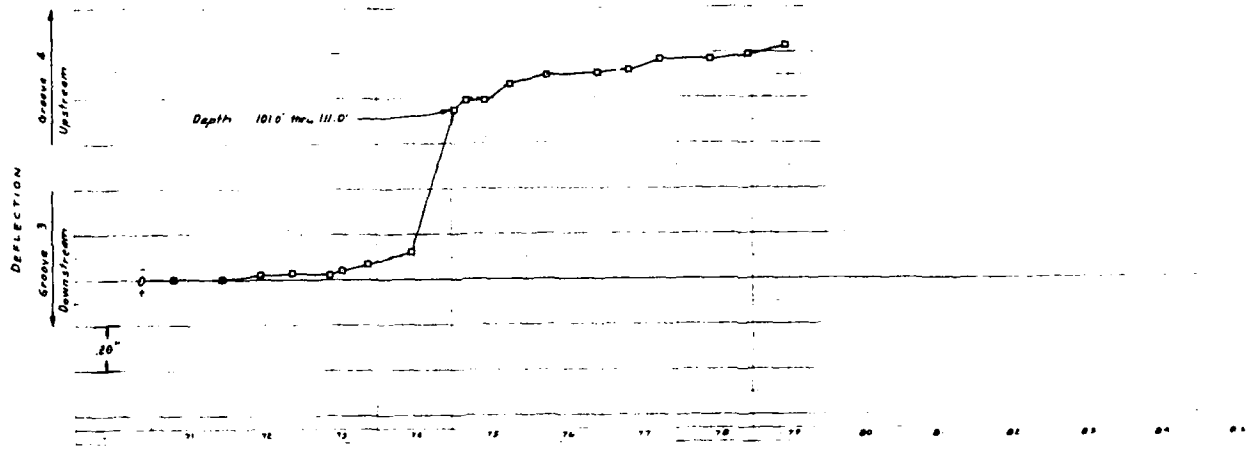
SAFETY PAYS

THIS PLAN ACCOMPANIES CONTRACT NO. DA-25-066-CIVENG-
CONSTRUCTION NO.

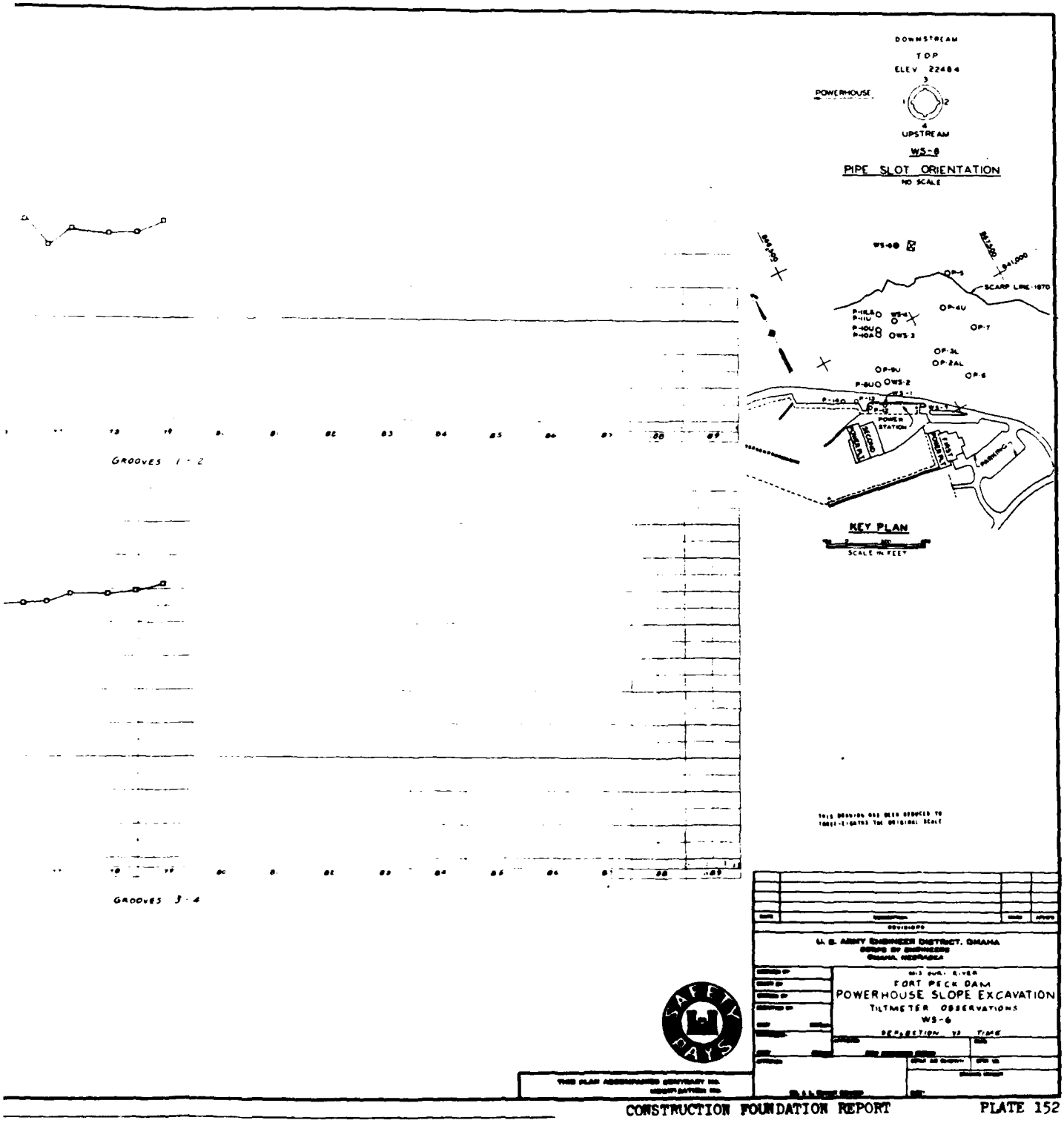
2

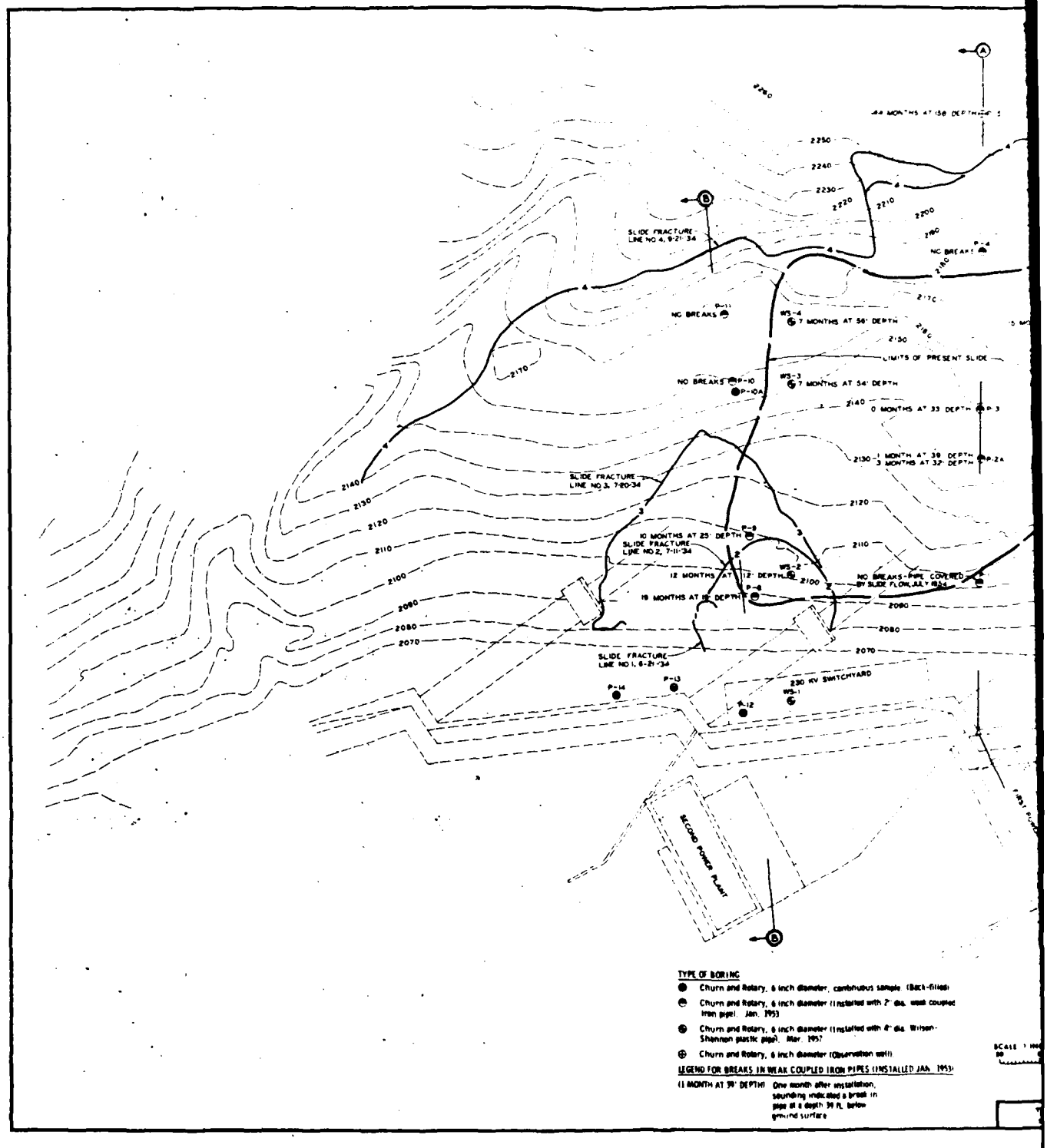


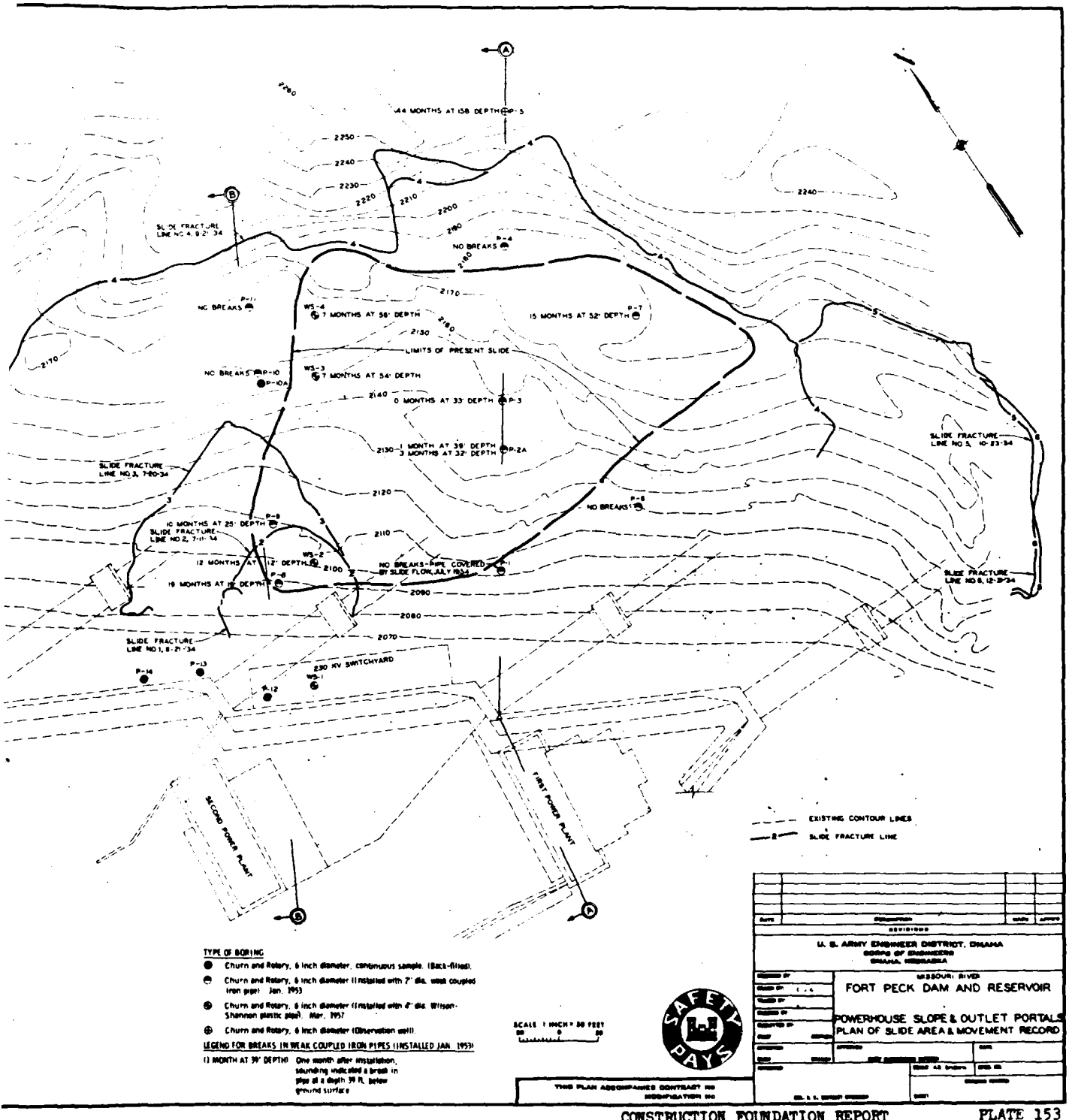
GROOVES 1 - 2



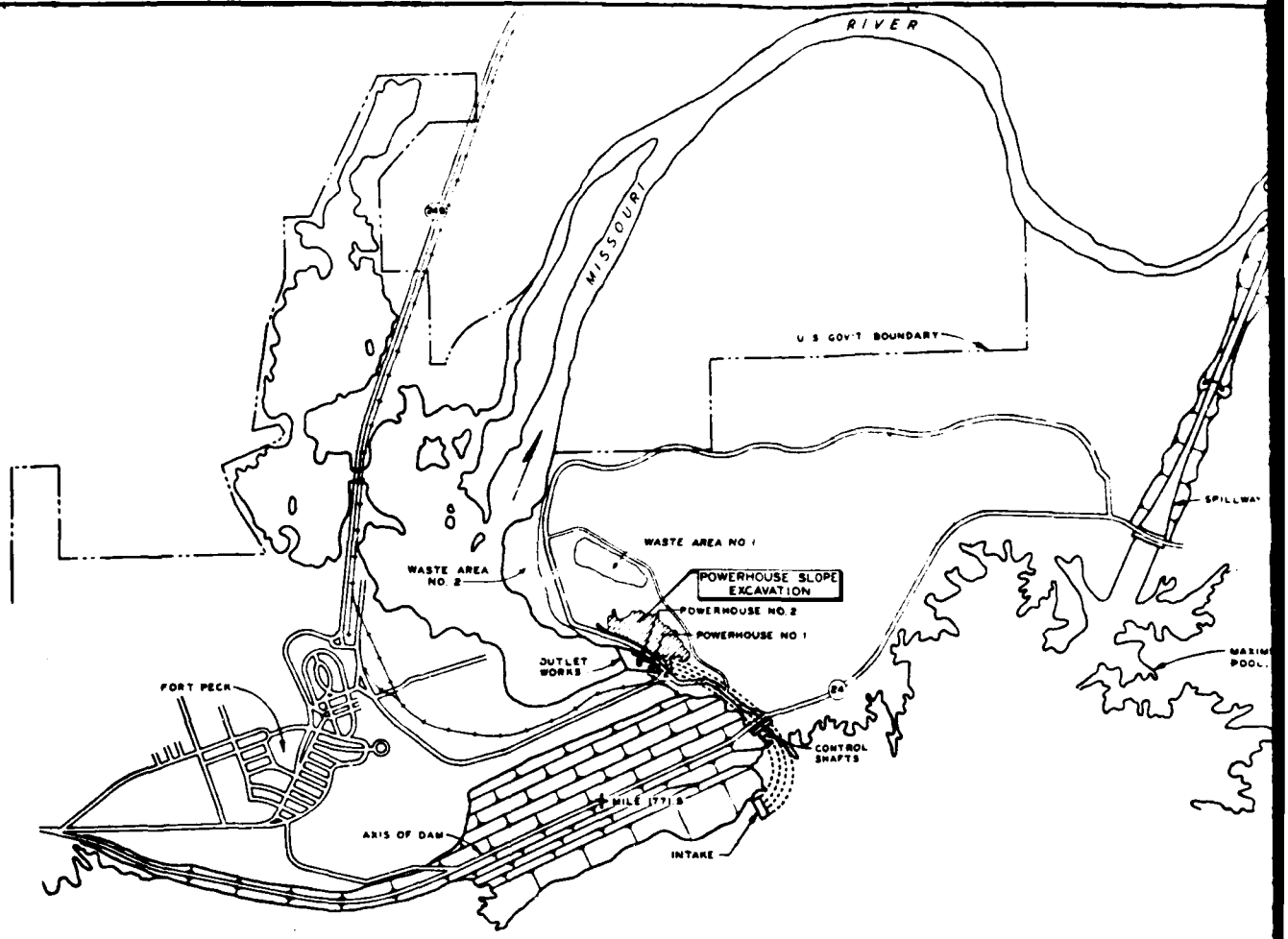
GROOVES 3 - 4


DOWNSTREAM
TOP
ELEV 2248.4
POWERHOUSE
UPSTREAM
WS-8
PIPE SLOT ORIENTATION
NO SCALE
WS-4B
OP-5
SCARP LINE 1870
OP-4U
OP-7
OWS-3
OP-3L
OP-2AL
OP-6
OP-9U
OWS-2
POWER STATION
SECOND
FIRST
PARKING
KEY PLAN
SCALE IN FEET
GROOVES 1-2
GROOVES 3-4
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK DAM
POWERHOUSE SLOPE EXCAVATION
TILTMETER OBSERVATIONS
WS-6
DEFLECTION VS TIME
SAFETY DAYS


A
B
SLIDE FRACTURE LINE NO 4, 9-21-34
NO BREAKS
P-11
WS-4
7 MONTHS AT 56' DEPTH
LIMITS OF PRESENT SLIDE
NO BREAKS
P-10
P-10A
WS-3
7 MONTHS AT 54' DEPTH
0 MONTHS AT 33 DEPTH
P-3
1 MONTH AT 39' DEPTH
3 MONTHS AT 32' DEPTH
P-2A
SLIDE FRACTURE LINE NO 3, 7-20-34
10 MONTHS AT 25' DEPTH
P-9
SLIDE FRACTURE LINE NO 2, 7-11-34
12 MONTHS AT 12' DEPTH
WS-2
P-8
19 MONTHS AT 15' DEPTH
NO BREAKS-PIPE COVERED BY SLIDE FLOW, JULY 1934
SLIDE FRACTURE LINE NO 1, 8-21-34
P-14
P-13
P-12
WS-1
230 KV SWITCHYARD
SECOND POWER PLANT
2250
2240
2230
2220
2210
2200
2190
2180
2170
2160
2150
2140
2130
2120
2110
2100
2090
2080
2070
TYPE OF BORING
Churn and Rotary, 6 inch diameter, continuous sample (Back-filled)
Churn and Rotary, 6 inch diameter (Installed with 2" dia. weak coupled iron pipe). Jan. 1953
Churn and Rotary, 6 inch diameter (Installed with 4" dia. Wilson-Shannon plastic pipe). Mar. 1957
Churn and Rotary, 6 inch diameter (Observation well)
LEGEND FOR BREAKS IN WEAK COUPLED IRON PIPES (INSTALLED JAN. 1953)
(1 MONTH AT 39' DEPTH) One month after installation, sounding indicated a break in pipe at a depth 39 ft. below ground surface

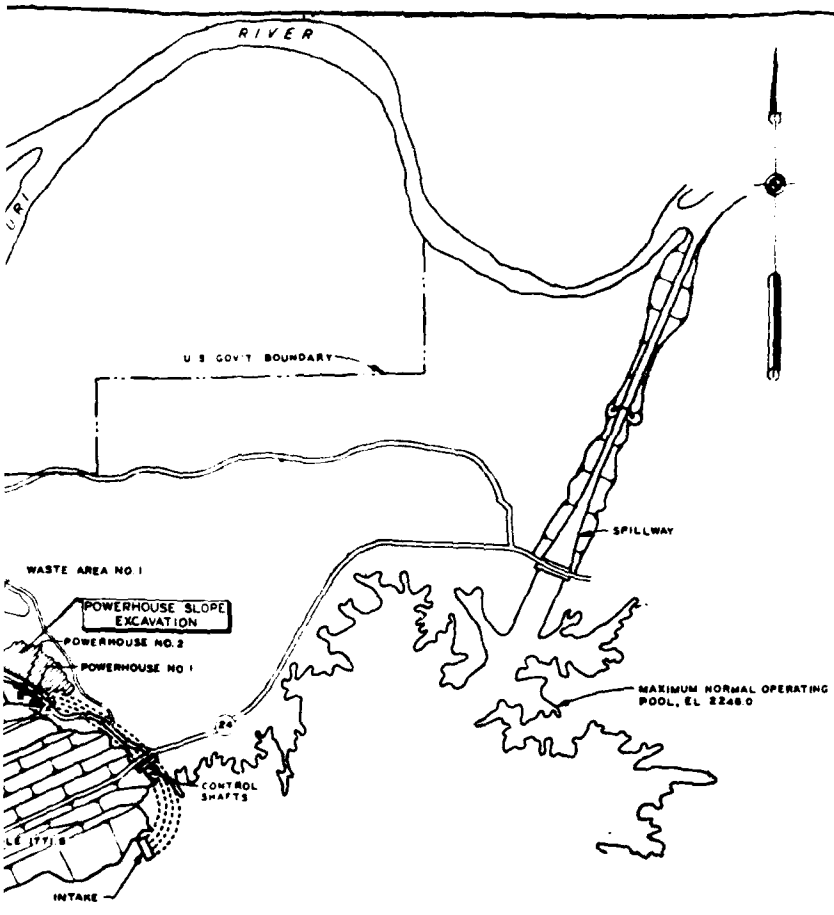

44 MONTHS AT 158' DEPTH P-5
SLIDE FRACTURE LINE NO 4, 9-2-34
NO BREAKS P-4
NO BREAKS P-11
WS-4 7 MONTHS AT 58' DEPTH
15 MONTHS AT 52' DEPTH P-7
LIMITS OF PRESENT SLIDE
NO BREAKS P-10 P-10A
WS-3 7 MONTHS AT 54' DEPTH
0 MONTHS AT 33' DEPTH P-3
1 MONTH AT 39' DEPTH
3 MONTHS AT 32' DEPTH P-2A
SLIDE FRACTURE LINE NO 3, 7-20-34
SLIDE FRACTURE LINE NO 3, 10-23-34
NO BREAKS P-6
10 MONTHS AT 25' DEPTH P-9
SLIDE FRACTURE LINE NO 2, 7-11-34
12 MONTHS AT 12' DEPTH WS-2
19 MONTHS AT 12' DEPTH P-8
NO BREAKS-PIPE COVERED BY SLIDE FLOW, ALT 19.4
SLIDE FRACTURE LINE NO 6, 12-3-34
SLIDE FRACTURE LINE NO 1, 8-21-34
P-14
P-13
P-12
230 KV SWITCHYARD
WS-1
SECOND POWER PLANT
FIRST POWER PLANT
EXISTING CONTOUR LINES
SLIDE FRACTURE LINE
TYPE OF BORING
Churn and Rotary, 6 inch diameter, continuous sample. (Back-filled).
Churn and Rotary, 6 inch diameter (Installed with 2" dia. weak coupled iron pipe) Jan. 1953
Churn and Rotary, 6 inch diameter (Installed with 4" dia. Wilson-Shannon plastic pipe). Mar. 1957
Churn and Rotary, 6 inch diameter (Observation well).
LEGEND FOR BREAKS IN WEAK COUPLED IRON PIPES (INSTALLED JAN. 1953)
(1) MONTH AT 39' DEPTH One month after installation, sounding indicated a break in pipe at a depth 39 ft. below ground surface
SCALE 1 INCH = 50 FEET
SAFETY PAYS
THIS PLAN ACCOMPANIES CONTRACT NO
MODIFICATION NO
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK DAM AND RESERVOIR
POWERHOUSE SLOPE & OUTLET PORTALS
PLAN OF SLIDE AREA & MOVEMENT RECORD

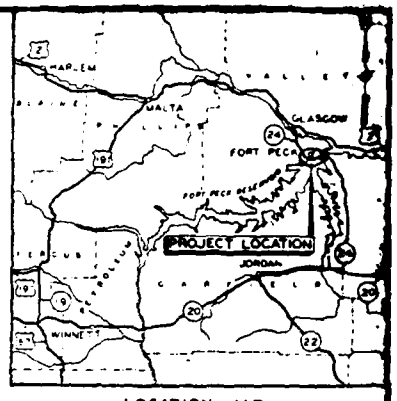
2



GENERAL PLAN

SCALE 1 INCH = 1500 FEET





LOCATION MAP
NO SCALE

GENERAL PLAN
SCALE 1 INCH = 600 FEET

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

DATE	DESCRIPTION	APPROVED	REVISIONS

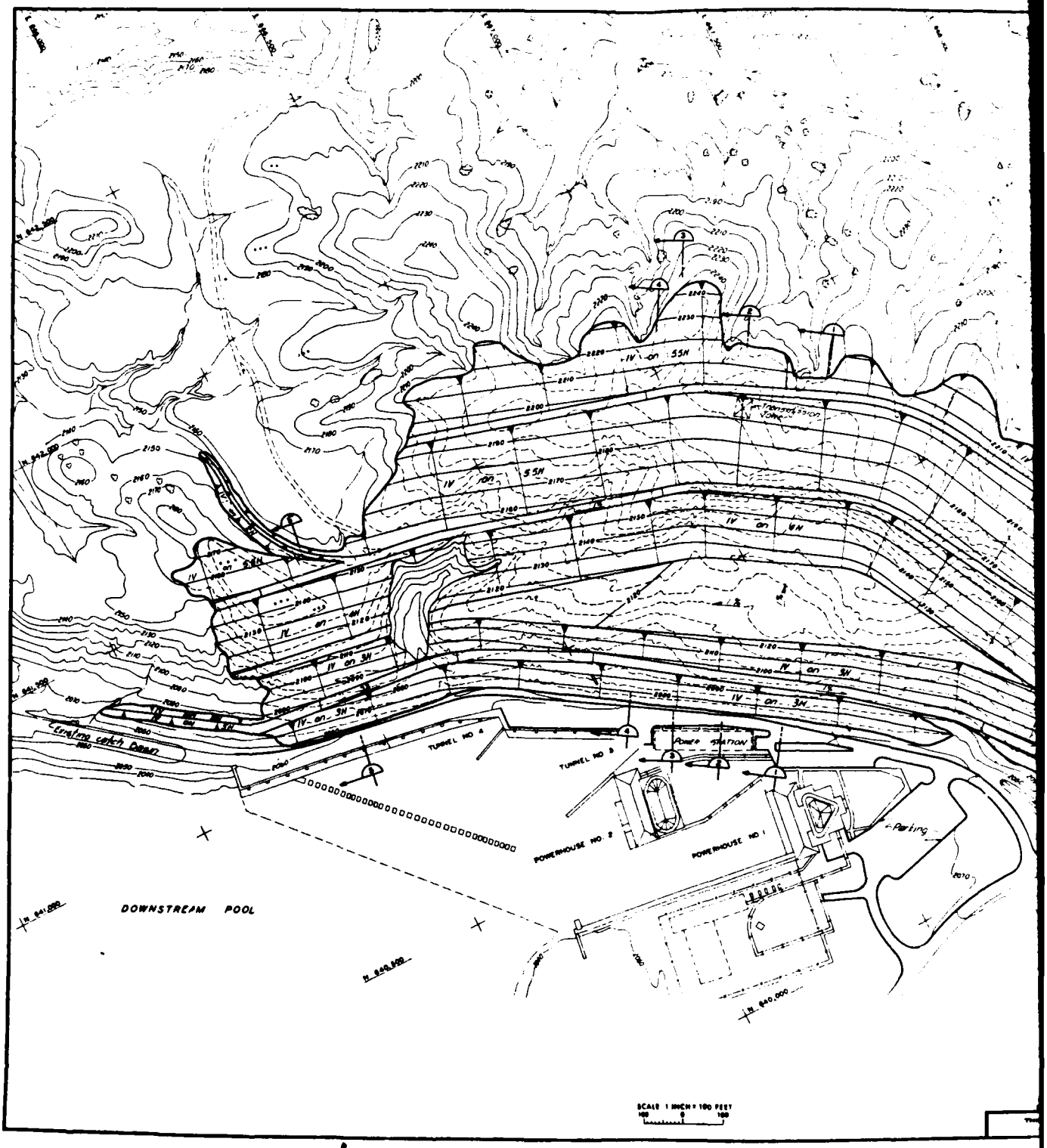
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

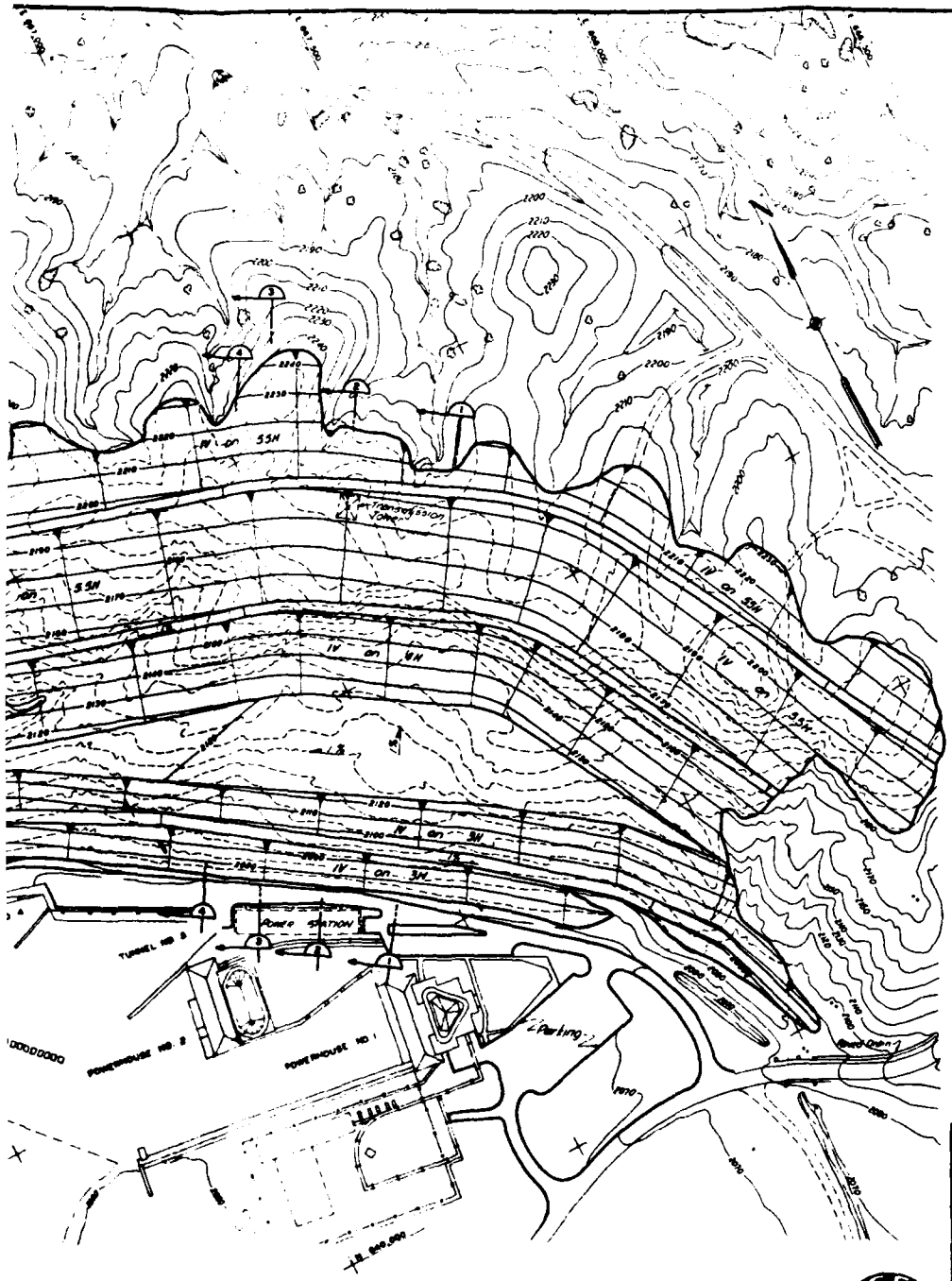
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GENERAL PLAN AND LOCATION MAP

JULY 1976

SAFETY PAYS

THIS PLAN ACCOMPANIES CONTRACT NO.
CONSTRUCTION NO.

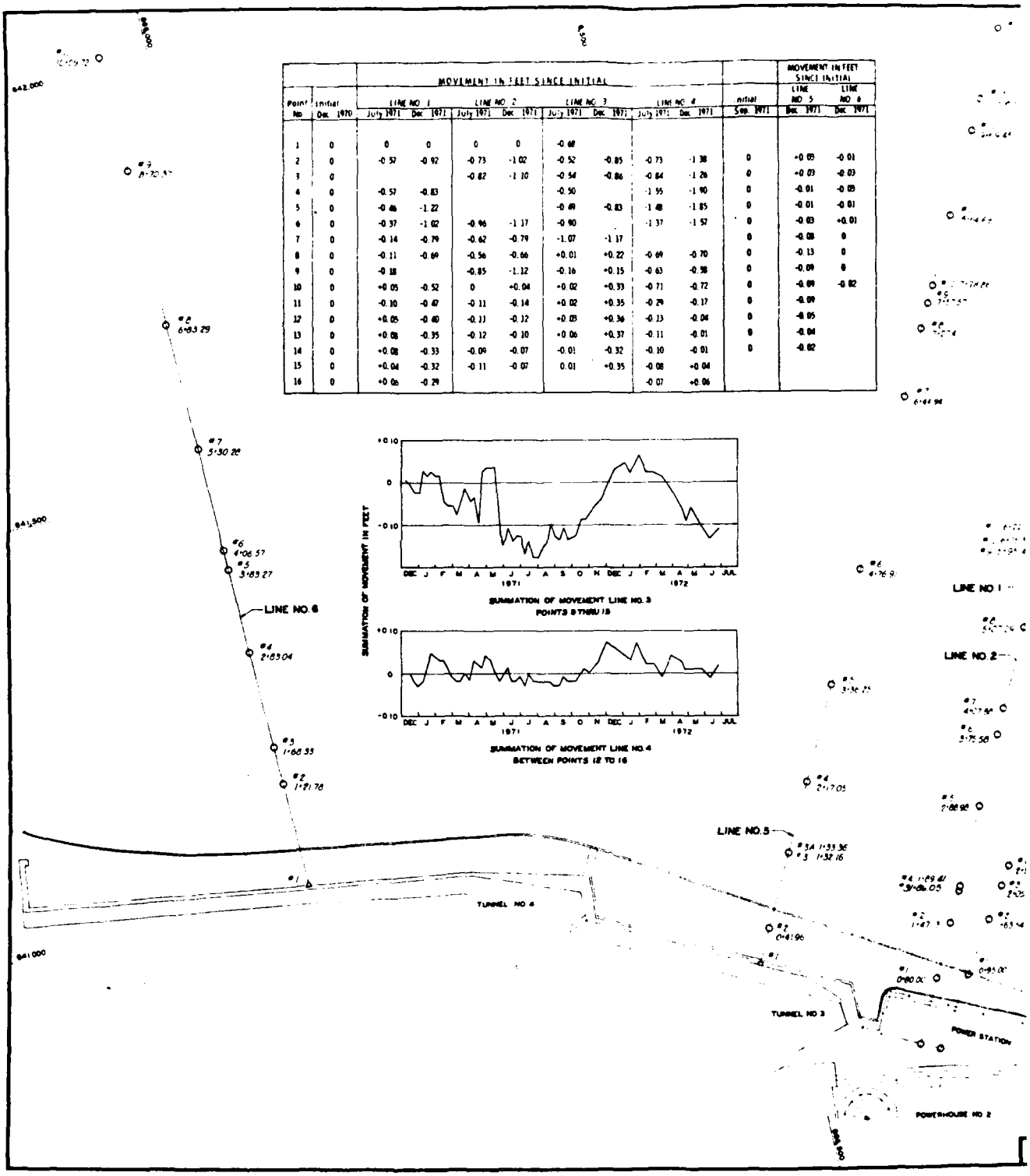

DOWNSTREAM POOL
POWERHOUSE NO. 2
POWERHOUSE NO. 1
TUNNEL NO. 4
TUNNEL NO. 3
POWER STATION
Parking
Transmission Yard
Existing catch basin
SCALE 1 INCH = 100 FEET


Transmission Towers
Power Station
Parking
Road Open
TUNNEL NO. 3
POWERHOUSE NO. 2
POWERHOUSE NO. 1
IV on 5½H
IV on 4H
IV on 3H
LEGEND
Proposed Excavation
Existing Ground Contours
Power Poles
Guard Rail
THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GRADING PLAN
JULY 1972
SAFETY PAYS
SCALE 1 INCH = 100 FEET
THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

FORT PECK POWERHOUSE SLOPE


FORT PECK POWERHOUSE SLOPE
LEGEND:
0.5 MOVEMENT CONTOURS IN FEET PER YEAR
PIPE LOCATIONS
50 0 50 100
SCALE
0.5
1.0
1.5
2.0
WS-4
WS-5
WS-2
WS-7
P-10A
P-11B
P-9A
P-9B
P-9N
P-4N
P-7
P-8
P-2
THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
MOVEMENT CONTOURS MAP
SAFETY PAYS
THIS PLAN ACCOMPANIES CONTRACT NO
MODIFICATION NO

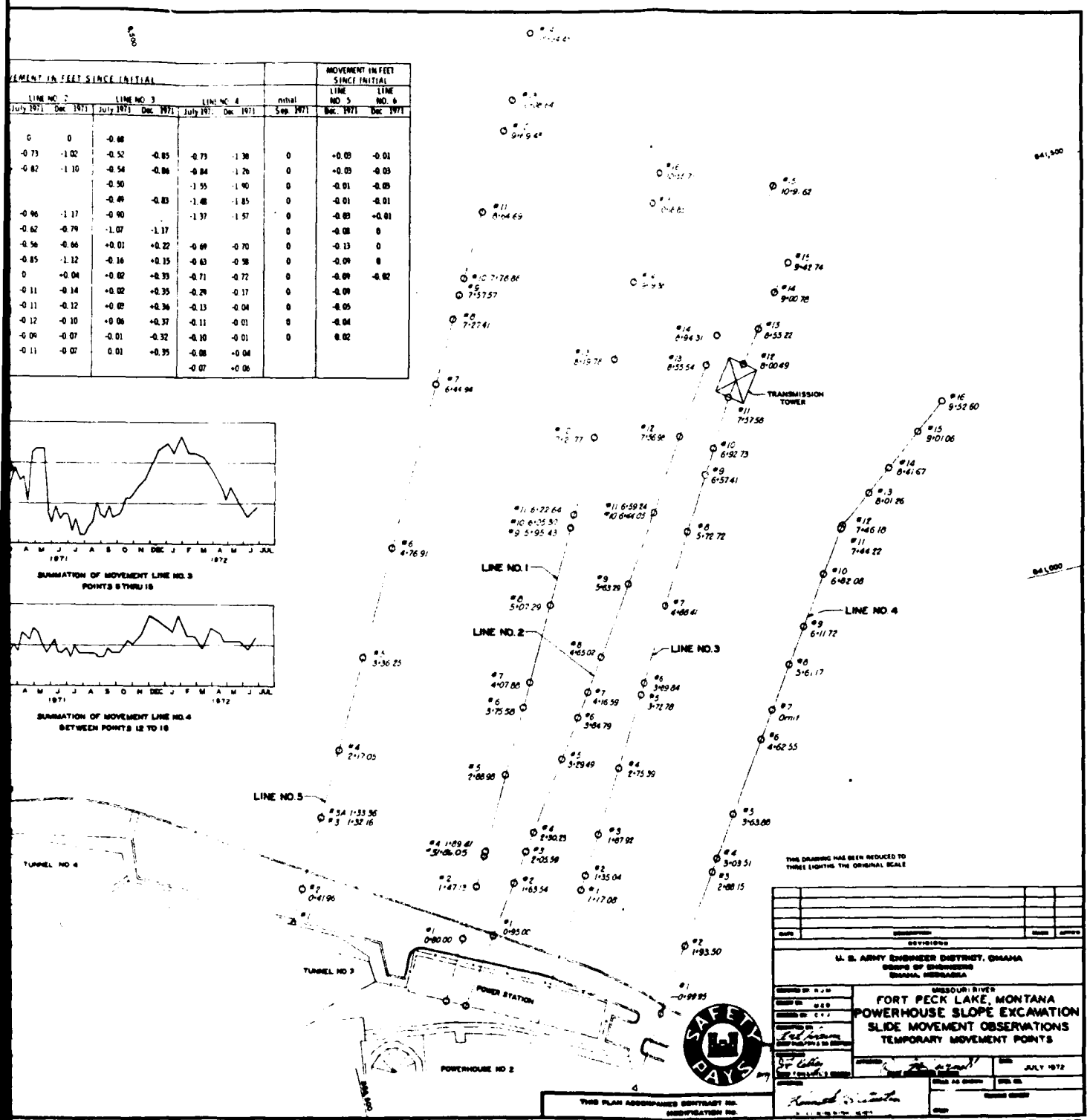
Point No	Initial Dec 1970	MOVEMENT IN FEET SINCE INITIAL: LINE NO 1 July 1971	LINE NO 1 Dec 1971	LINE NO 2 July 1971	LINE NO 2 Dec 1971	LINE NO 3 July 1971	LINE NO 3 Dec 1971	LINE NO 4 July 1971	LINE NO 4 Dec 1971	Initial Sep 1971	MOVEMENT IN FEET SINCE INITIAL: LINE NO 5 Dec 1971	LINE NO 6 Dec 1971
1	0	0	0	0	0	-0.68						
2	0	-0.57	-0.92	-0.73	-1.02	-0.52	-0.85	-0.73	-1.38	0	+0.05	-0.01
3	0			-0.82	-1.10	-0.54	-0.86	-0.84	-1.26	0	+0.03	-0.03
4	0	-0.57	-0.83			-0.50		-1.55	-1.90	0	-0.01	-0.05
5	0	-0.46	-1.22			-0.49	-0.83	-1.48	-1.85	0	-0.01	-0.01
6	0	-0.37	-1.02	-0.96	-1.17	-0.90		-1.37	-1.52	0	-0.03	+0.01
7	0	-0.14	-0.79	-0.62	-0.79	-1.07	-1.17			0	-0.08	0
8	0	-0.11	-0.69	-0.56	-0.66	+0.01	+0.22	-0.69	-0.70	0	-0.13	0
9	0	-0.18		-0.85	-1.12	-0.16	+0.15	-0.63	-0.58	0	-0.09	0
10	0	+0.05	-0.52	0	+0.04	+0.02	+0.33	-0.71	-0.72	0	-0.09	-0.02
11	0	-0.10	-0.47	-0.11	-0.14	+0.02	+0.35	-0.29	-0.17	0	-0.09	
12	0	+0.05	-0.40	-0.11	-0.12	+0.03	+0.36	-0.13	-0.04	0	-0.05	
13	0	+0.08	-0.35	-0.12	-0.10	+0.06	+0.37	-0.11	-0.01	0	-0.04	
14	0	+0.08	-0.33	-0.09	-0.07	-0.01	-0.32	-0.10	-0.01	0	-0.02	
15	0	+0.04	-0.32	-0.11	-0.07	0.01	+0.35	-0.08	+0.04			
16	0	+0.06	-0.29					-0.07	+0.06			



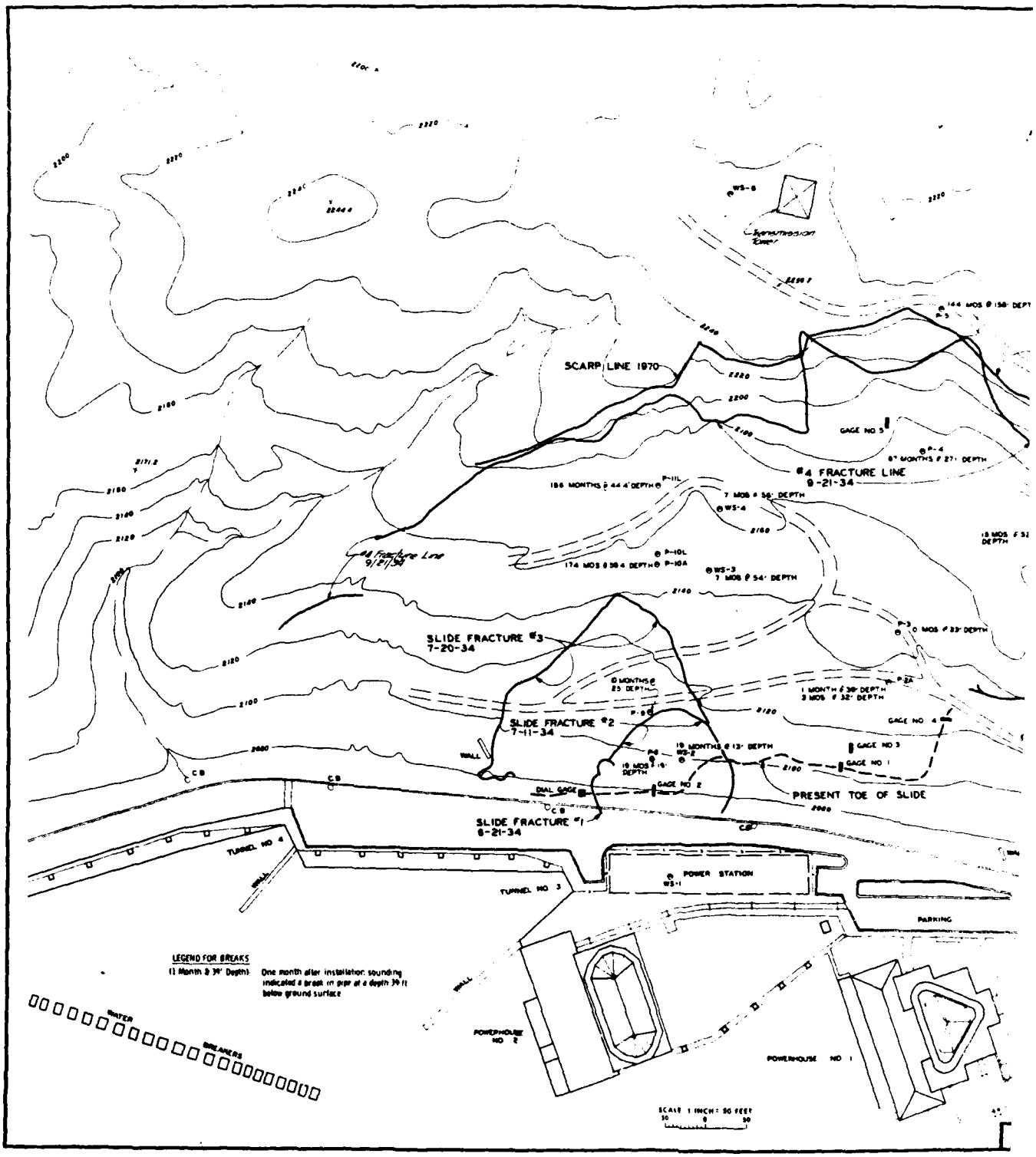
MOVEMENT IN FEET SINCE INITIAL								
LINE NO. 2		LINE NO. 3		LINE NO. 4		initial	LINE NO. 5	LINE NO. 6
July 1971	Dec. 1971	July 1971	Dec. 1971	July 1971	Dec. 1971	Sep. 1971	Dec. 1971	Dec. 1971
0	0	-0.68						
-0.73	-1.02	-0.52	-0.85	-0.73	-1.38	0	+0.03	-0.01
-0.82	-1.10	-0.54	-0.86	-0.84	-1.26	0	+0.03	-0.03
		-0.50		-1.55	-1.90	0	-0.01	-0.05
		-0.49	-0.83	-1.48	-1.85	0	-0.01	-0.01
-0.96	-1.17	-0.90		-1.37	-1.57	0	-0.03	+0.01
-0.62	-0.79	-1.07	-1.17			0	-0.08	0
-0.56	-0.66	+0.01	+0.22	-0.69	-0.70	0	-0.13	0
-0.85	-1.12	-0.16	+0.15	-0.63	-0.58	0	-0.09	0
0	+0.04	+0.02	+0.33	-0.71	-0.72	0	-0.09	-0.02
-0.11	-0.14	+0.02	+0.35	-0.29	-0.17	0	-0.09	
-0.11	-0.12	+0.02	+0.36	-0.13	-0.04	0	-0.05	
-0.12	-0.10	+0.06	+0.37	-0.11	-0.01	0	-0.04	
-0.09	-0.07	-0.01	-0.32	-0.10	-0.01	0	0.02	
-0.11	-0.07	0.01	+0.35	-0.08	+0.04			
				-0.07	+0.06			

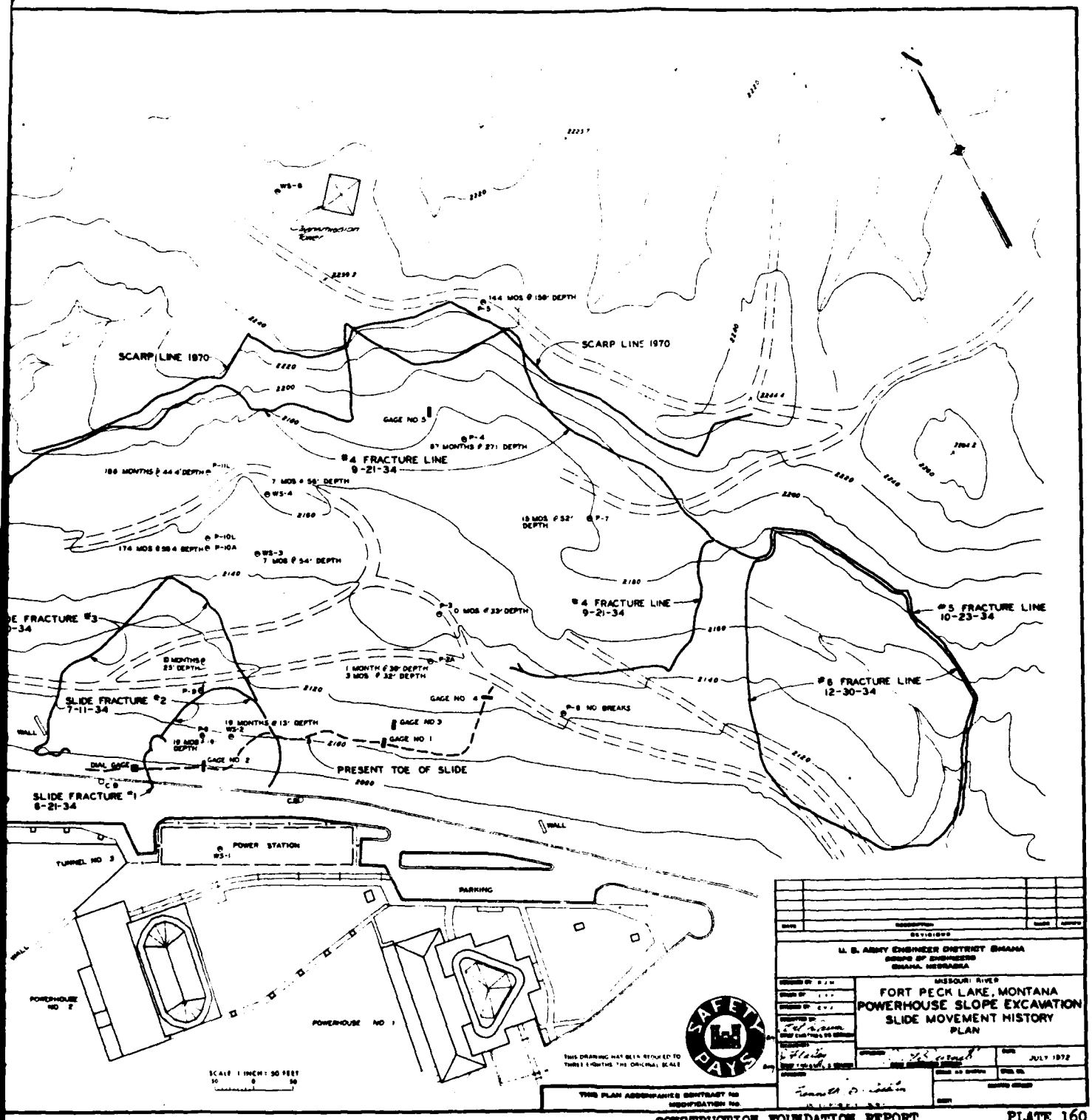
SUMMATION OF MOVEMENT LINE NO. 3
POINTS 8 THRU 16

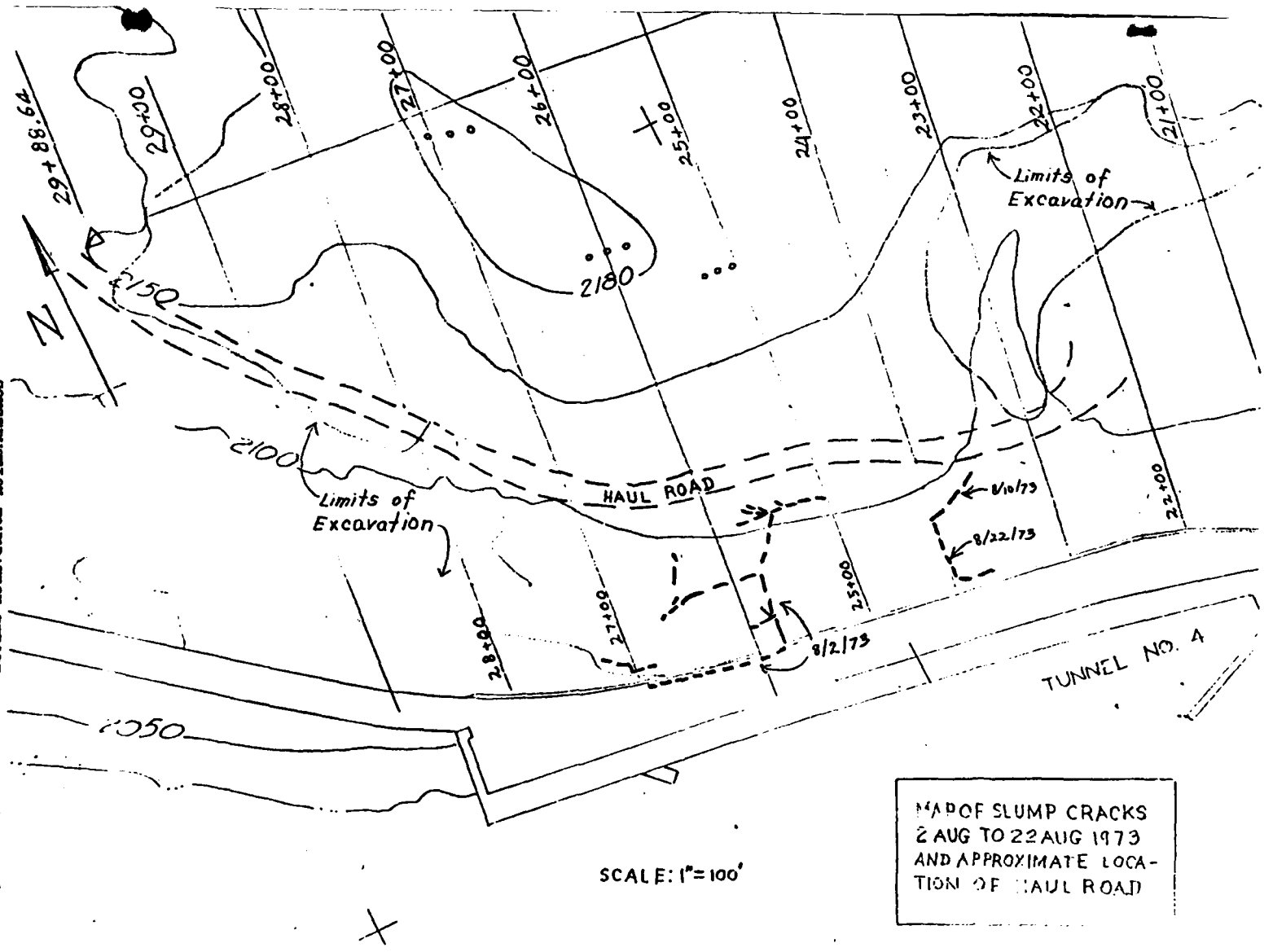
SUMMATION OF MOVEMENT LINE NO. 4
BETWEEN POINTS 12 TO 16



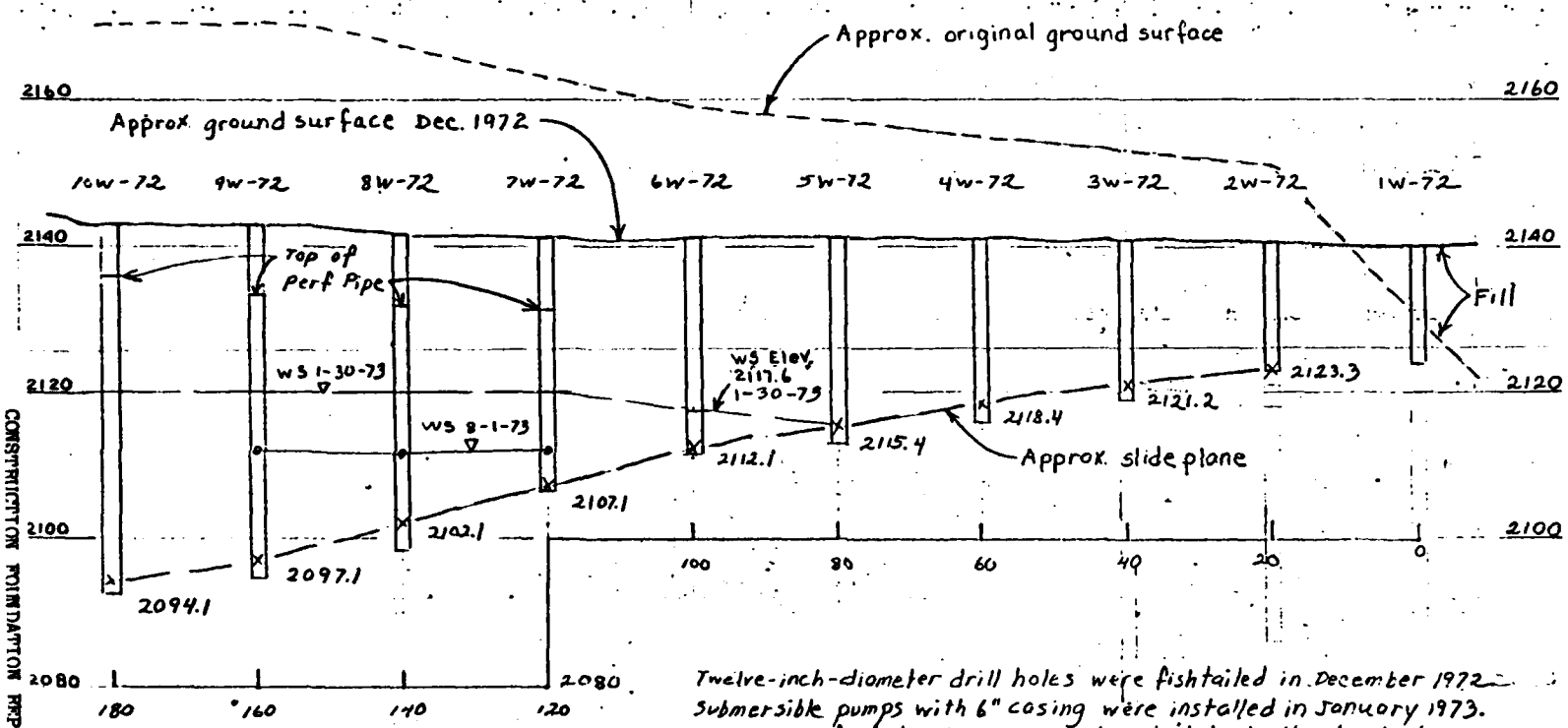
2


SCARP LINE 1970
#4 FRACTURE LINE
9-21-34
SLIDE FRACTURE #3
7-20-34
SLIDE FRACTURE #2
7-11-34
SLIDE FRACTURE #1
8-21-34
PRESENT TOE OF SLIDE
GAGE NO 5
GAGE NO 4
GAGE NO 3
GAGE NO 1
GAGE NO 2
DIAL GAGE
WALL
TUNNEL NO 4
TUNNEL NO 3
POWER STATION
PARKING
POWERHOUSE NO 2
POWERHOUSE NO 1
WATER
BREAKERS
LEGEND FOR BREAKS
(1 Month @ 39' Depth)
One month after installation: sounding indicated a break in pipe at a depth 39 ft below ground surface
SCALE 1 INCH = 50 FEET


SCARP LINE 1970
SCARP LINE 1970
#4 FRACTURE LINE
9-21-34
#4 FRACTURE LINE
9-21-34
#5 FRACTURE LINE
10-23-34
#6 FRACTURE LINE
12-30-34
SLIDE FRACTURE #2
7-11-34
SLIDE FRACTURE #1
8-21-34
PRESENT TOE OF SLIDE
GAGE NO 5
GAGE NO 4
GAGE NO 3
GAGE NO 1
GAGE NO 2
POWER STATION
TUNNEL NO 3
PARKING
POWERHOUSE NO 2
POWERHOUSE NO 1
WALL
SCALE 1 INCH = 50 FEET
U. S. ARMY ENGINEER DISTRICT OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
SLIDE MOVEMENT HISTORY
PLAN
JULY 1972
SAFETY PAYS



MAP OF SLUMP CRACKS 2 AUG TO 22 AUG 1973 AND APPROXIMATE LOCATION OF HAUL ROAD



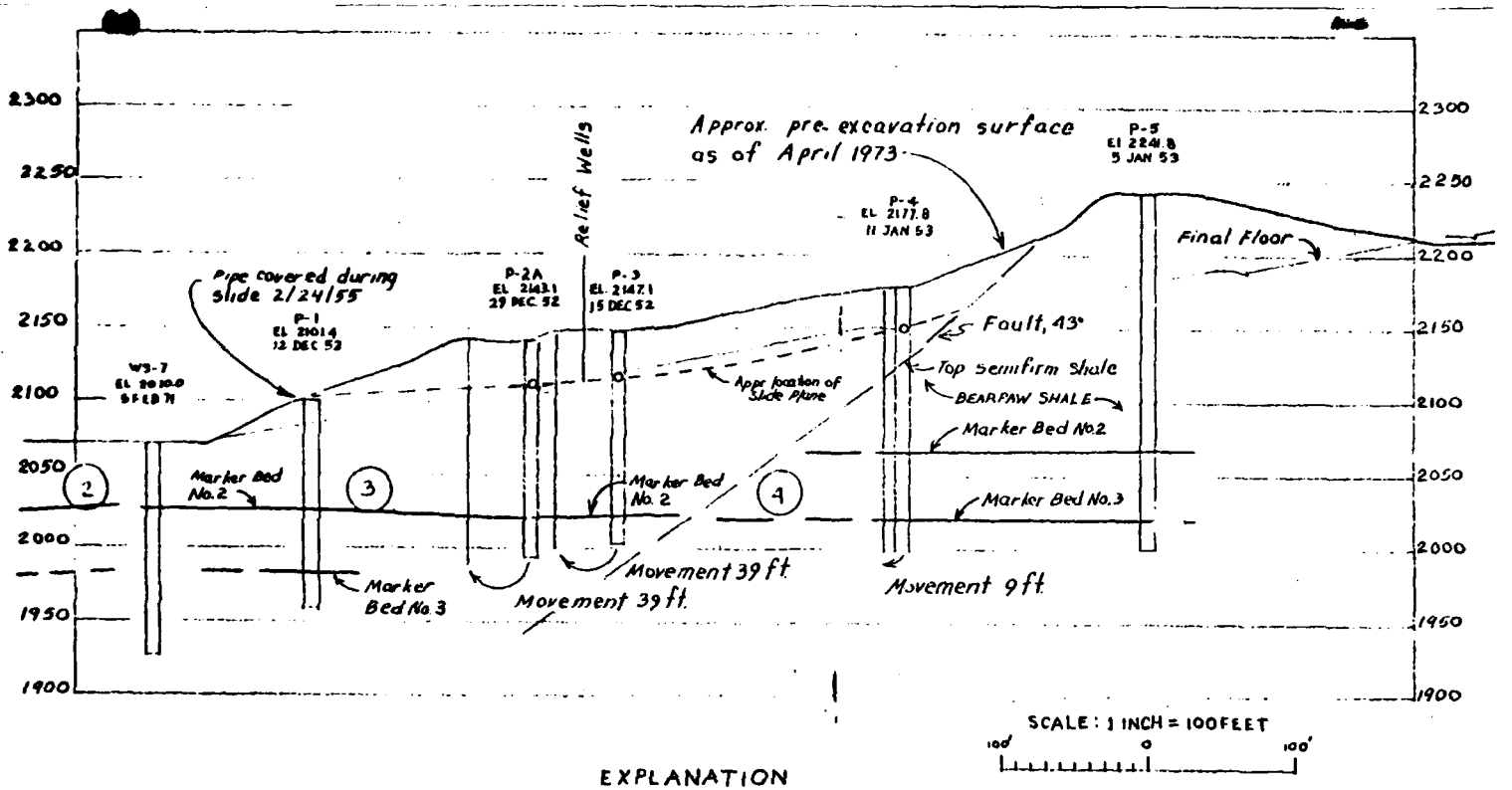
WELL	Bot. Screen Elev.
7	2107.5
8	2102.1
9	2097.1
10	2094.1

Twelve-inch-diameter drill holes were fishtailed in December 1972. Submersible pumps with 6" casing were installed in January 1973. Elevation of slide plane was estimated by depth at which unweathered shale was encountered. Total amount of water pumped was 34,859 gallons from 31 Jan to 1 Aug. 1973. Water was not encountered in wells 1 thru 5 and pumps & casing were not installed in wells 1 thru 6. Pumps in wells 8, 9 & 10 took most of the load.

20' 0 20'

SCALE: 1 INCH = 20 FEET.

FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
SHALE DRAINAGE SECTION



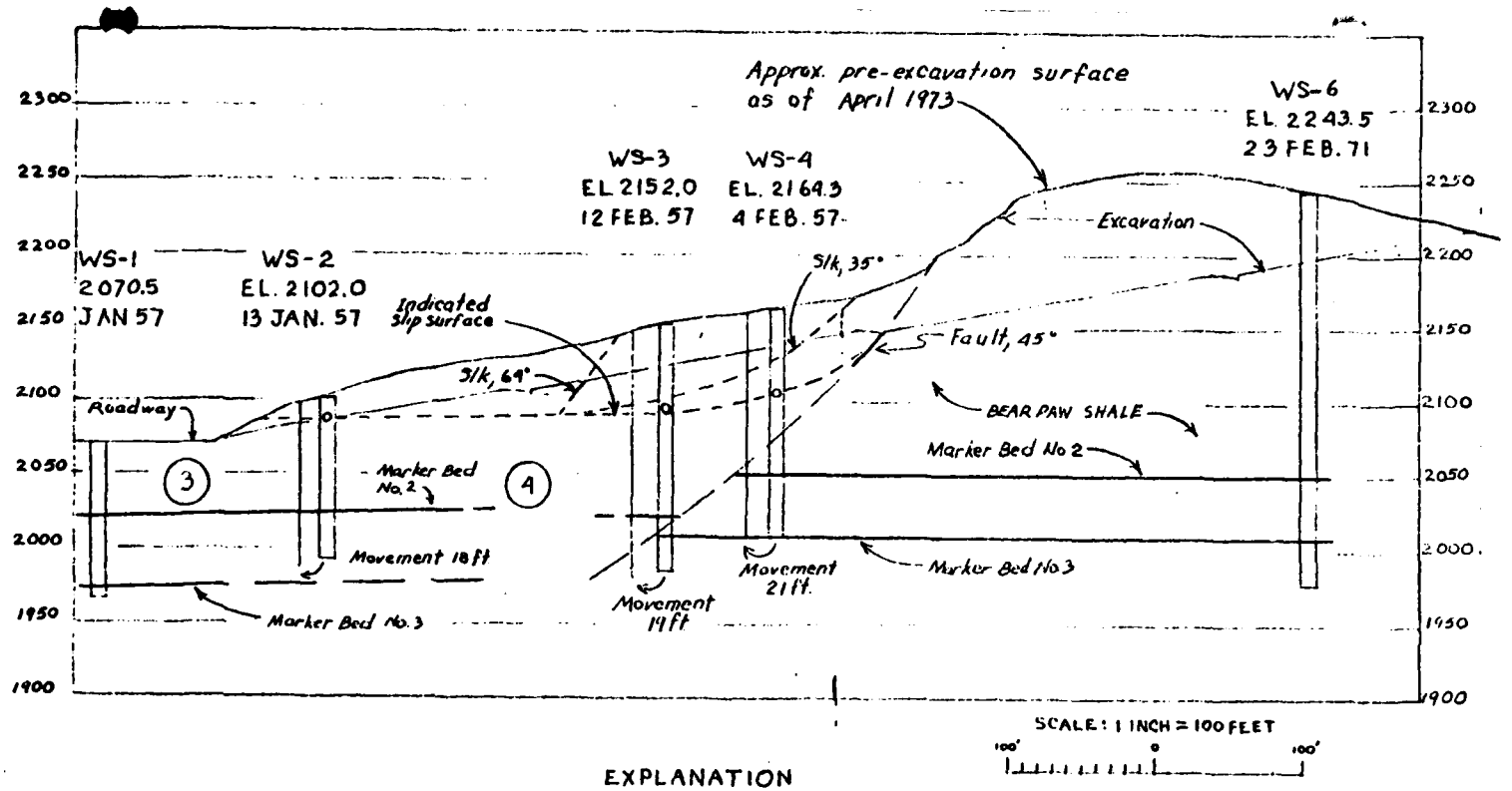
EXPLANATION

Movement readings for instruments were last taken in April 1973

Position of pipe break

Outlet tunnel

FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC PROFILE
WS-7 THRU P-5



EXPLANATION

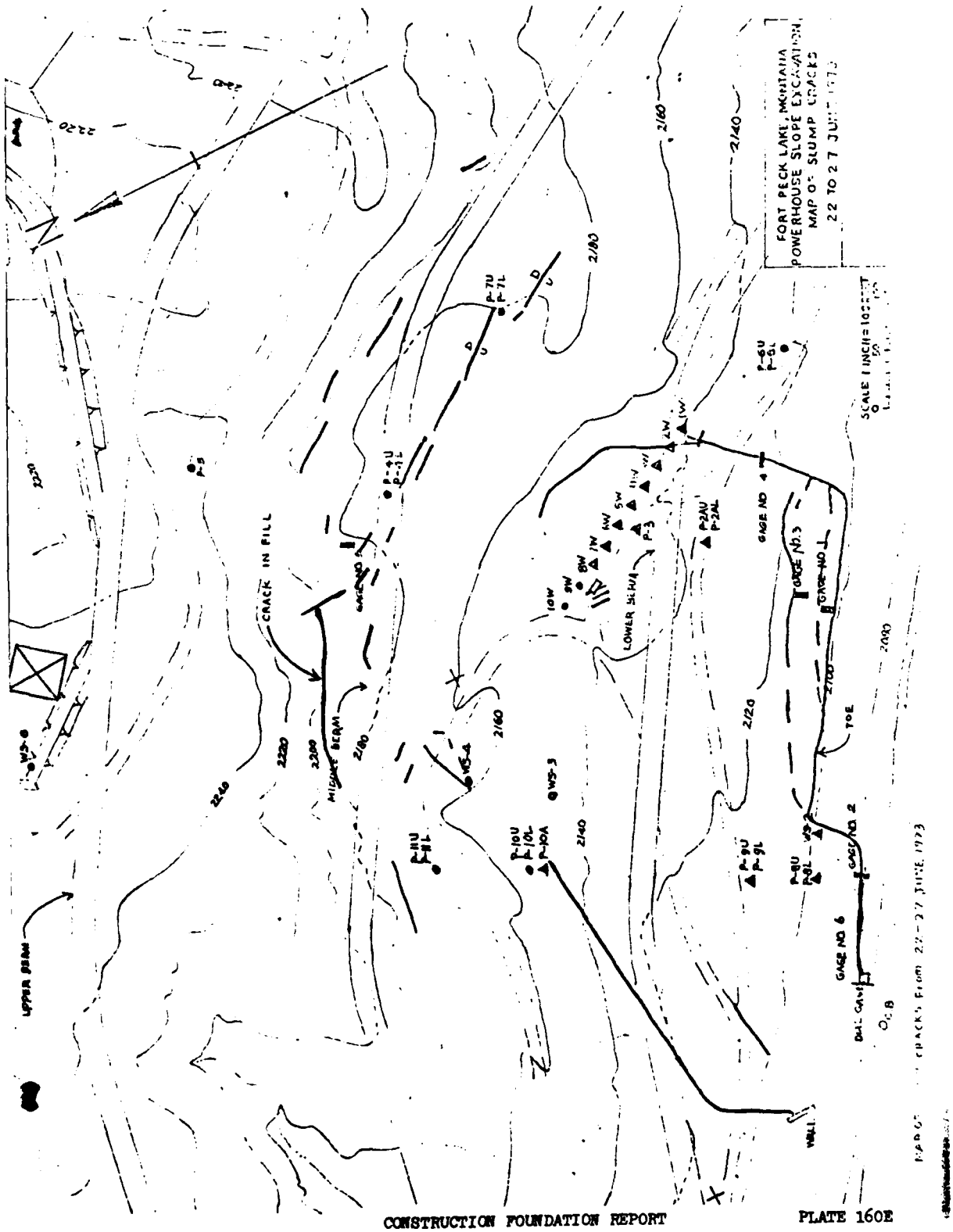
Movement readings for instruments were last taken in April 1973

• Position of pipe break

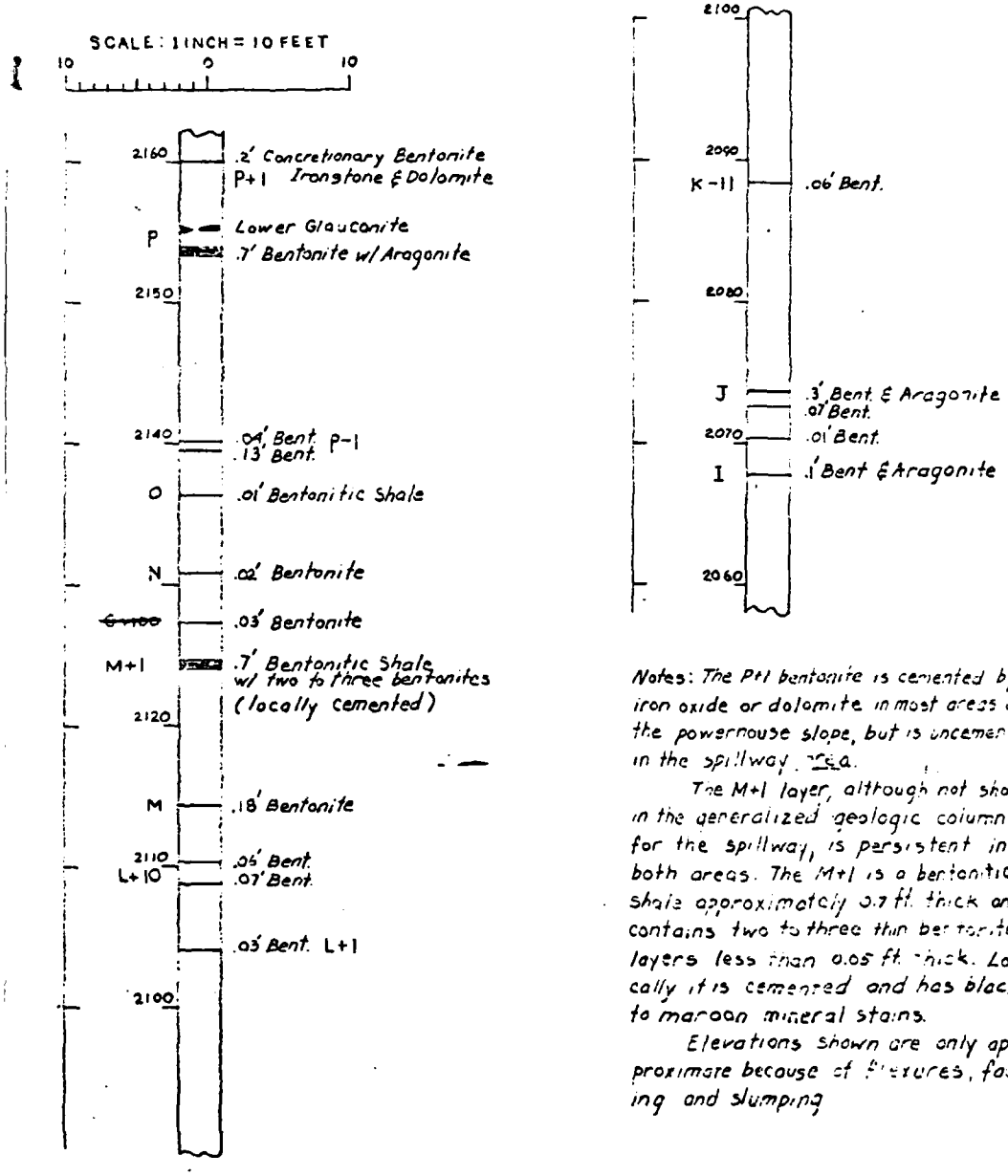
Outlet tunnel

FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC PROFILE
WS-1 THRU WS-6

For location of instruments see plate No. 11.


FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
MAP OF SLUMP CRACKS
22 TO 27 JUNE 1973
SCALE 1 INCH = 100 FEET
CRACK IN FILL
MISSING BERM
UPPER BERM
LOWER BERM
TOE
GAGE NO 1
GAGE NO 2
GAGE NO 3
GAGE NO 4
GAGE NO 6
2220
2240
2200
2180
2160
2140
2120
2100
2080
2060

GENERALIZED GEOLOGIC COLUMN OF BENTONITES
OBSERVED DURING SURFACE MAPPING

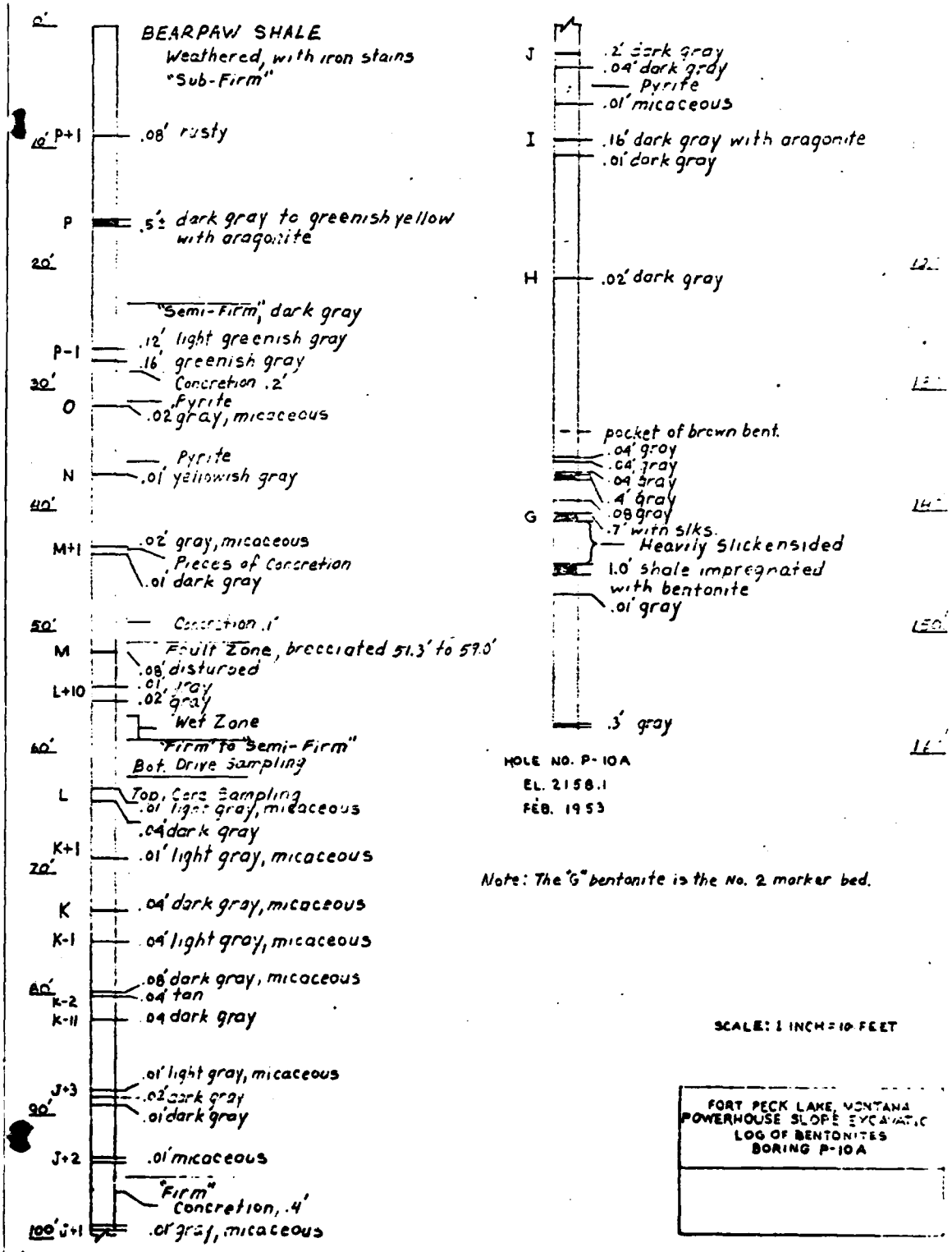


Notes: The P+1 bentonite is cemented by iron oxide or dolomite in most areas of the powerhouse slope, but is uncemented in the spillway area.

The M+1 layer, although not shown in the generalized geologic column for the spillway, is persistent in both areas. The M+1 is a bentonitic shale approximately 0.7 ft. thick and contains two to three thin bentonite layers less than 0.05 ft. thick. Locally it is cemented and has black to maroon mineral stains.

Elevations shown are only approximate because of flexures, faulting and slumping

FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC COLUMN

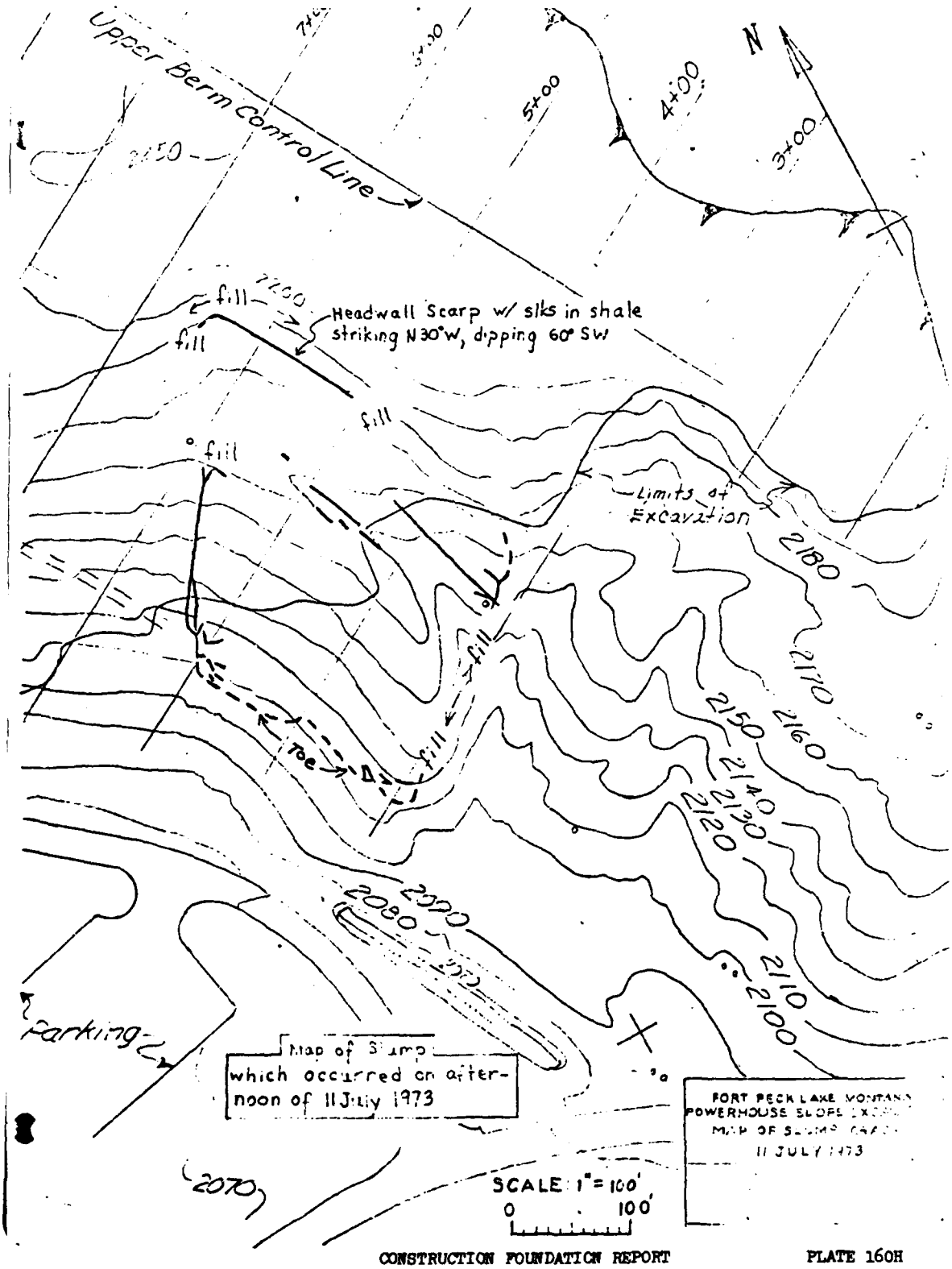


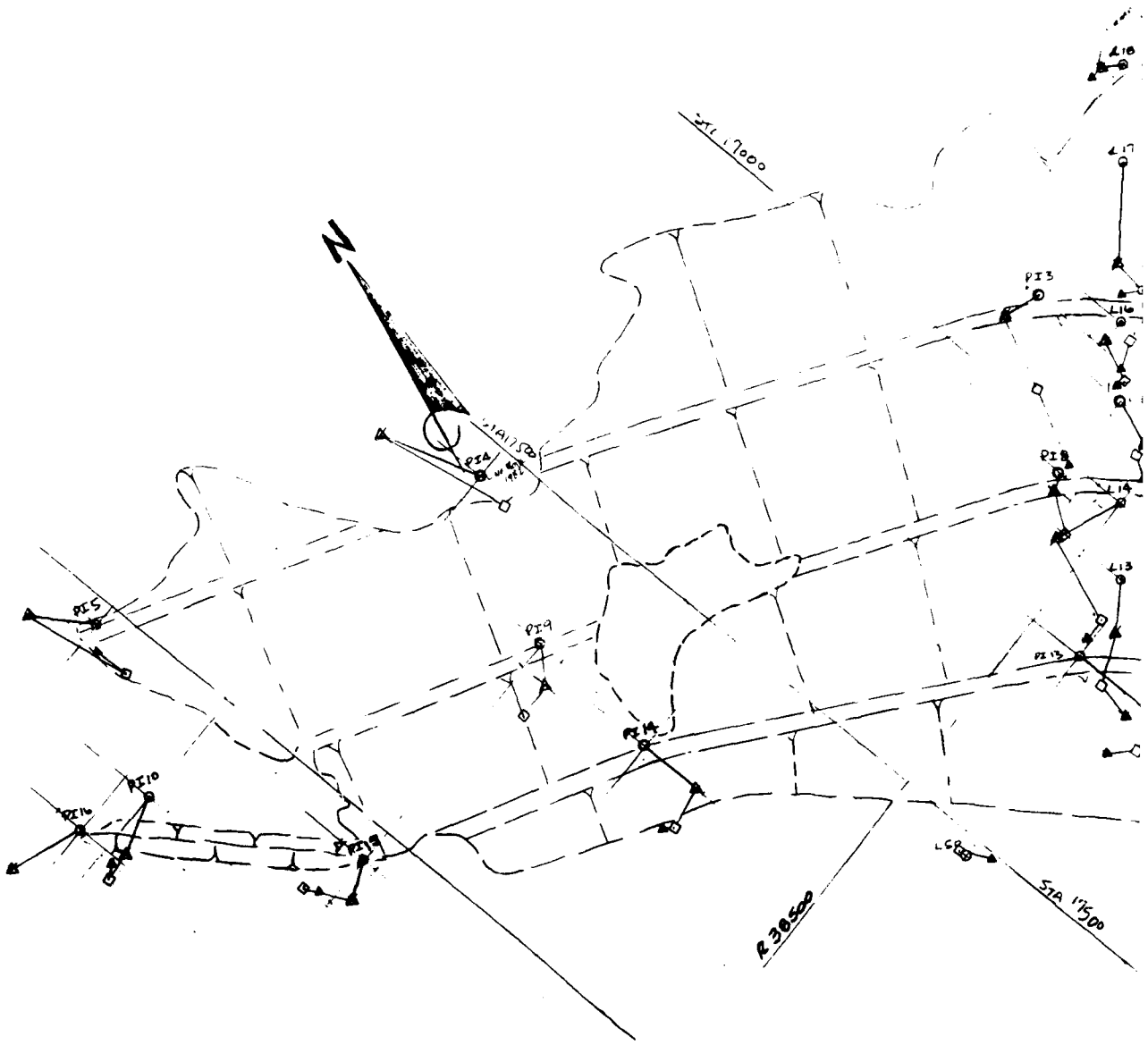
HOLE NO. P-10A
EL. 2158.1
FEB. 1953

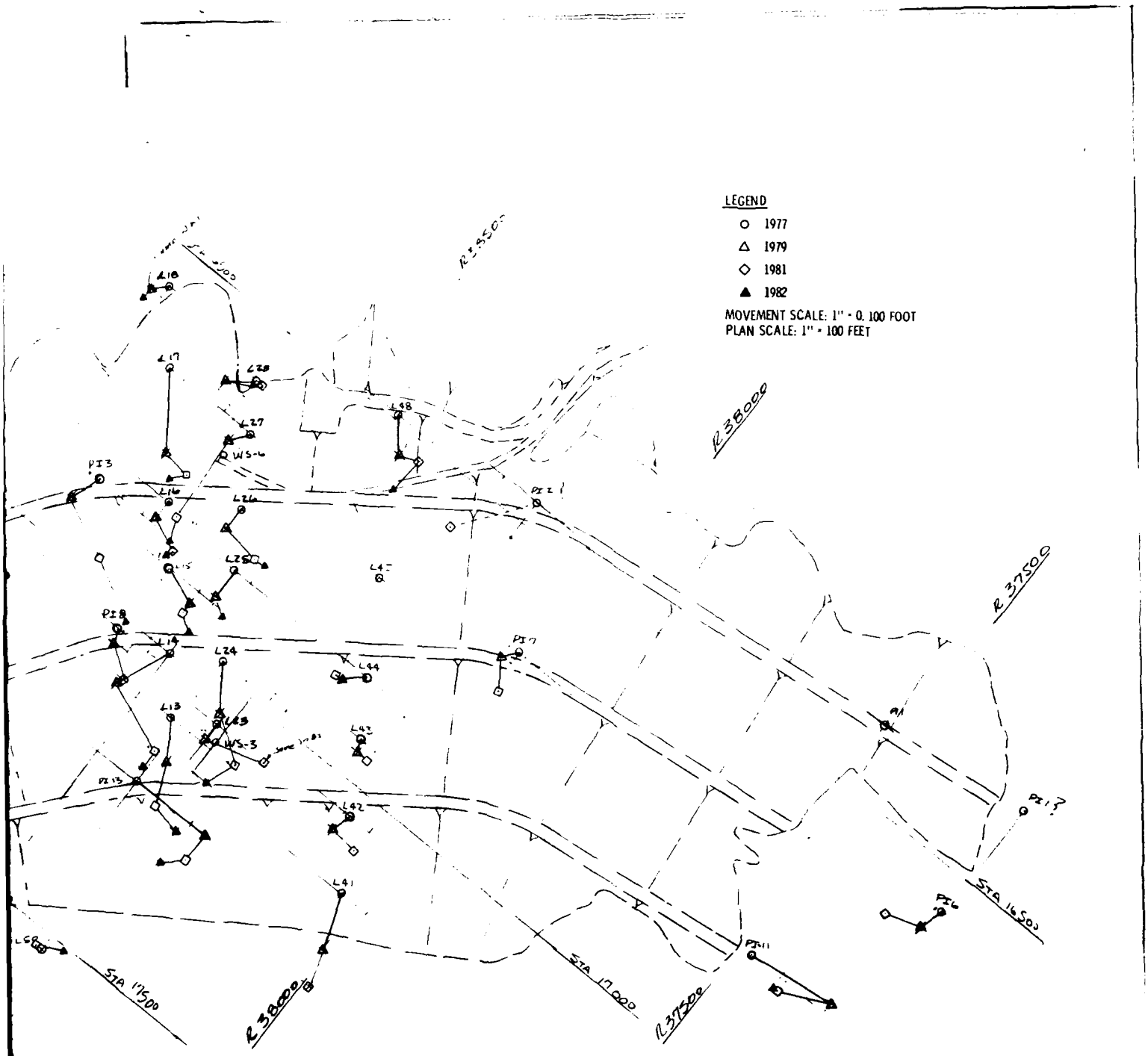
Note: The "G" bentonite is the No. 2 marker bed.

SCALE: 1 INCH = 10 FEET

FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
LOG OF BENTONITES
BORING P-10A

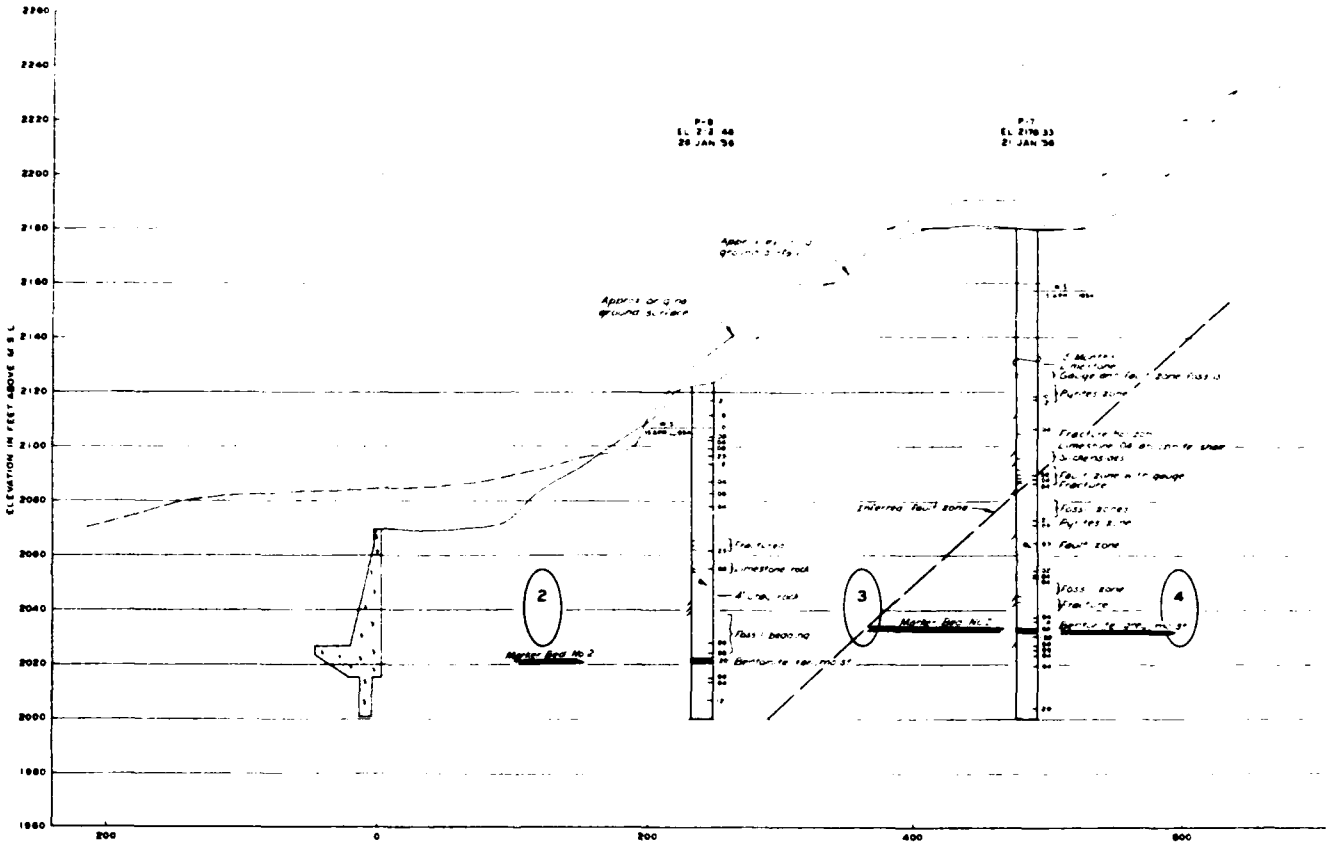

Upper Berm Control Line
N
4+00
5+00
3+00
fill
fill
Headwall Scarp w/ slks in shale striking N30°W, dipping 60° SW
fill
fill
Limits of Excavation
2180
2170
2160
2150
2140
2130
2120
2110
2100
2090
2080
Toe
fill
fill
Parking
2070
Map of Slump which occurred on afternoon of 11 July 1973
FORT PECK LAKE MONTANA
POWERHOUSE SLOPE
MAP OF SLUMP
11 JULY 1973
SCALE 1" = 100'
0 100'


N
PI 3
PI 4
PI 5
PI 9
PI 10
PI 13
PI 14
PI 16
L 10
L 13
L 14
L 16
L 17
L 68
R 38500
STA 175500

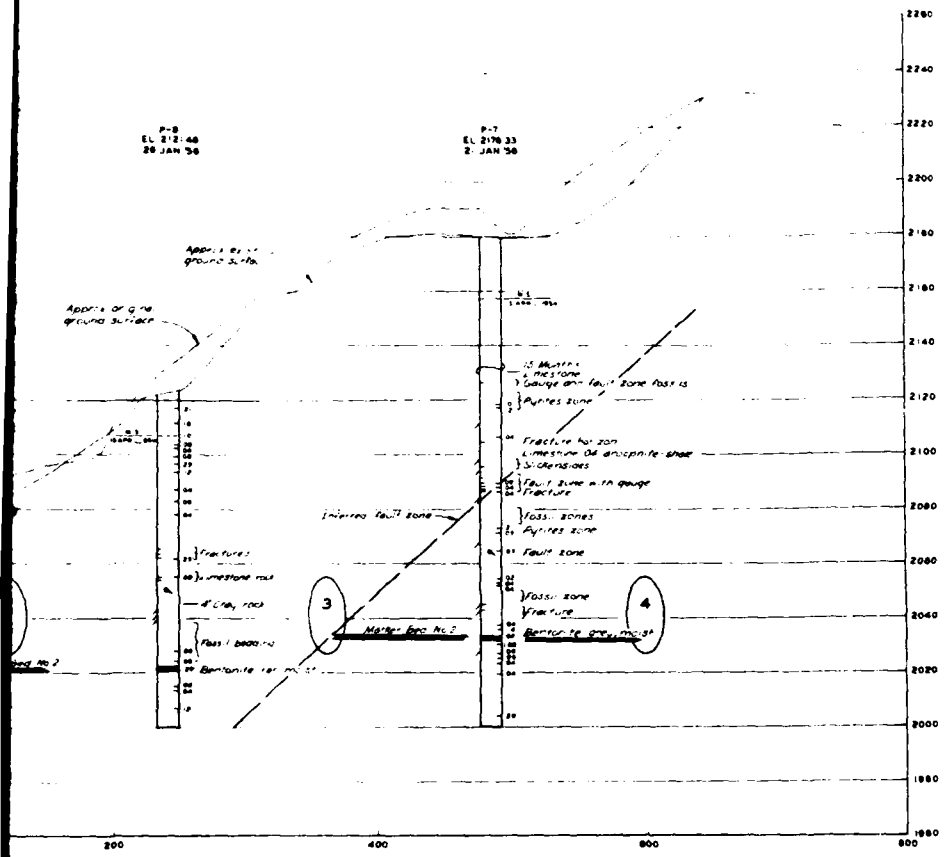


MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE MOVEMENT
1977 - 1982
U.S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS OMAHA, NEBRASKA

CONSTRUCTION FOUNDATION REPORT 2 PLATE 160I



SCALE VERT 1 INCH = 20 FEET
HORIZ 1 INCH = 40 FEET



LEGEND

- HOLE NUMBER
- ASPHALT AND GRAVEL OR WEATHERED SHALE
- BENTONITE
- SLICKENSIDES
- JOINT
- LOST CORE
- CONCRETIONS
- 15 MONTHS - PIPE BREAK
- 6 NO INDICATES THICKNESS IN FEET

SCALE: VERT 1 INCH = 20 FEET
HORIZ 1 INCH = 40 FEET

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

DATE	DESCRIPTION	CHECK	APPROV
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC PROFILE
P-8 & P-7

JULY 1972

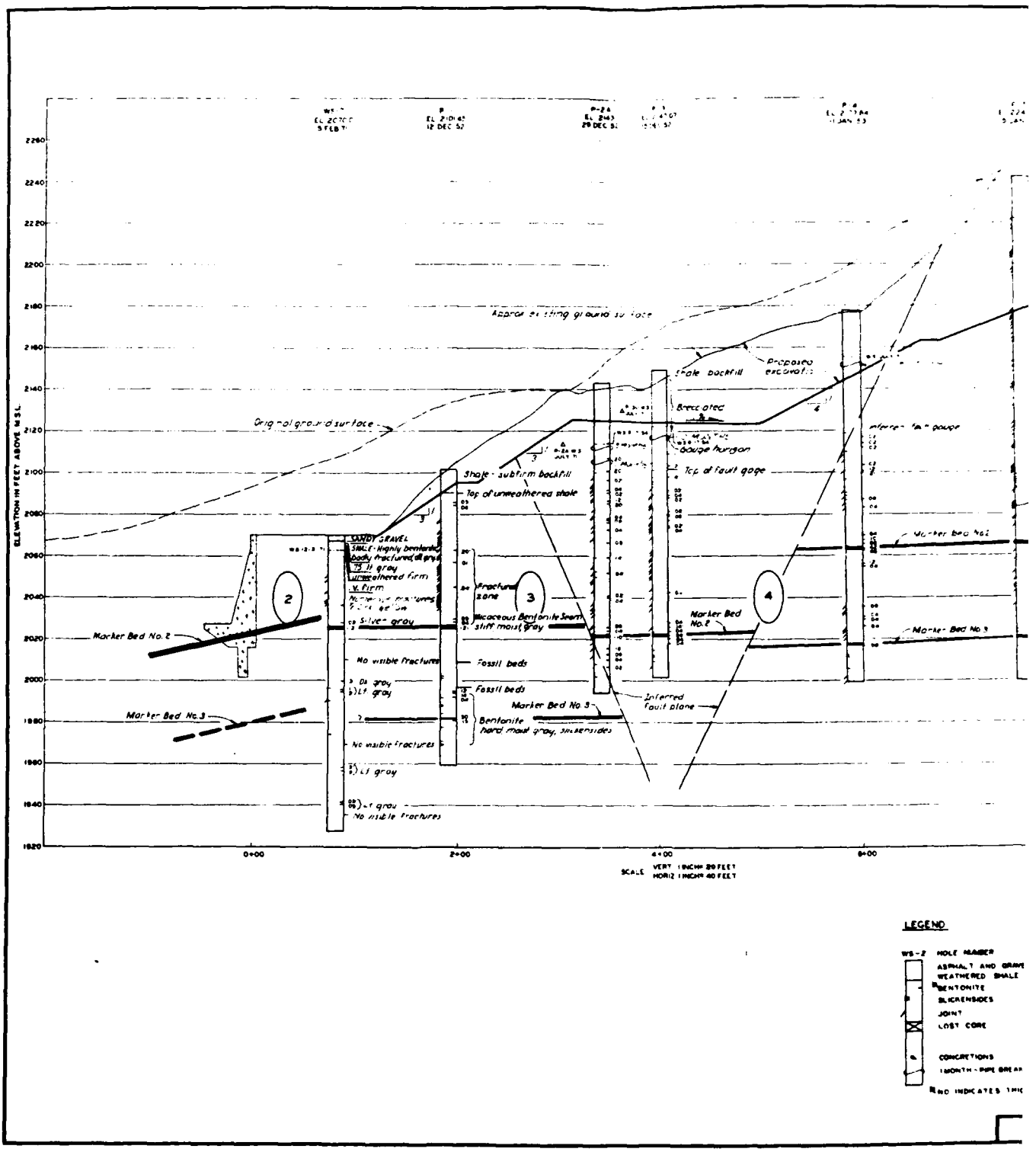
SAFETY PAYS

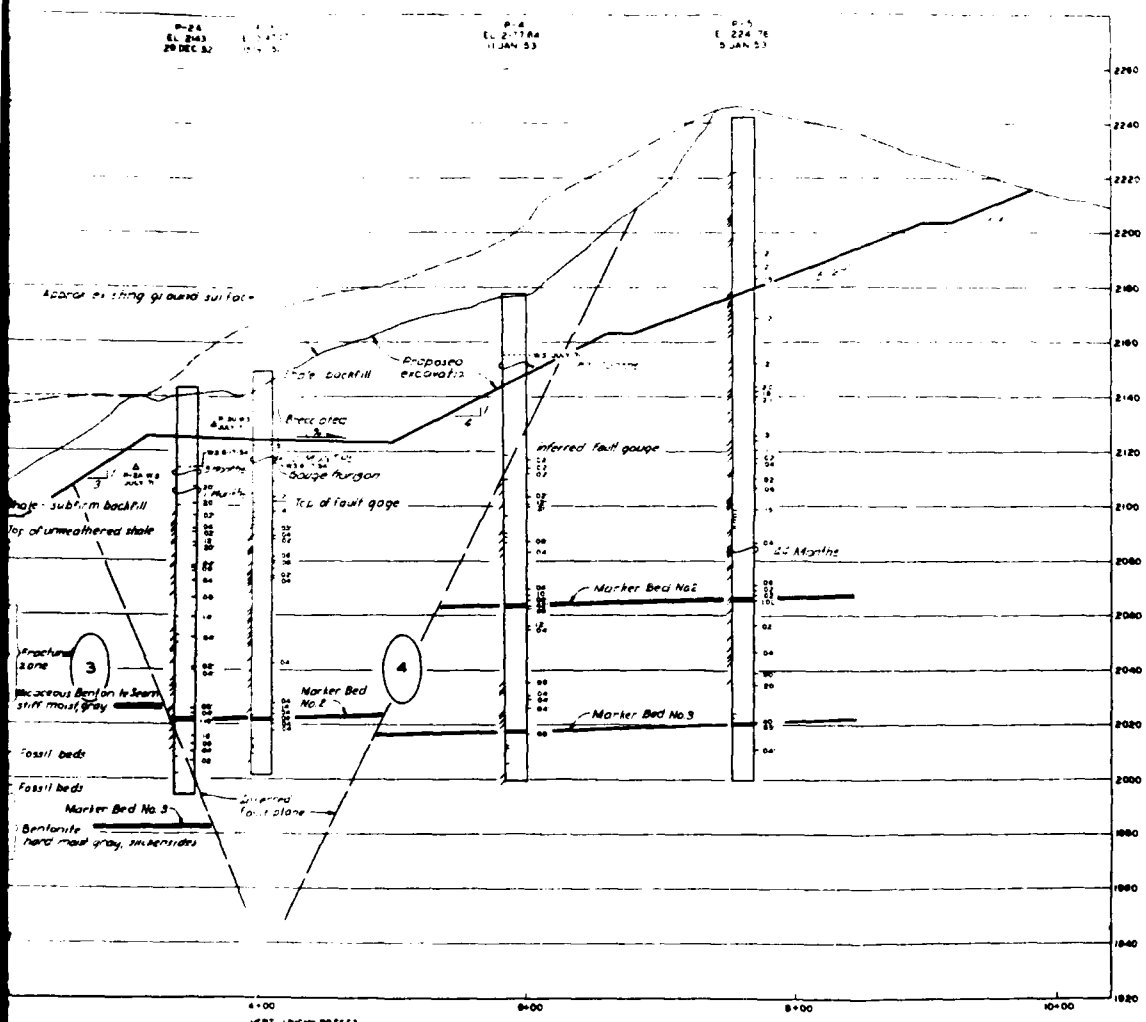
THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO

CONSTRUCTION FOUNDATION REPORT

PLATE 161

2


ELEVATION IN FEET ABOVE M.S.L.
2260
2240
2220
2200
2180
2160
2140
2120
2100
2080
2060
2040
2020
2000
1980
1960
1940
1920
0+00
2+00
4+00
6+00
SCALE VERT 1 INCH = 20 FEET
HORIZ 1 INCH = 40 FEET
Original ground surface
Shale backfill
Breccia
Gouge horizon
Top of fault gouge
Shale - subfirm backfill
Top of unweathered shale
SANDY GRAVEL
Silver gray
Marker Bed No. 2
Marker Bed No. 3
No visible fractures
Fossil beds
Fractured zone
Micaceous Bentonite Seam
Bentonite
hard moist gray, slickensides
Inferred fault plane
Marker Bed No. 2
Marker Bed No. 3
2
3
4
LEGEND
WS-2 HOLE NUMBER
ASPHALT AND GRAVEL
WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
1 MONTH - PIPE BREAK



SCALE VERT 1 INCH = 20 FEET
HORIZ 1 INCH = 40 FEET

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

LEGEND

WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
1 MONTH - PIPE BREAK
NO INDICATES THICKNESS IN FEET

THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

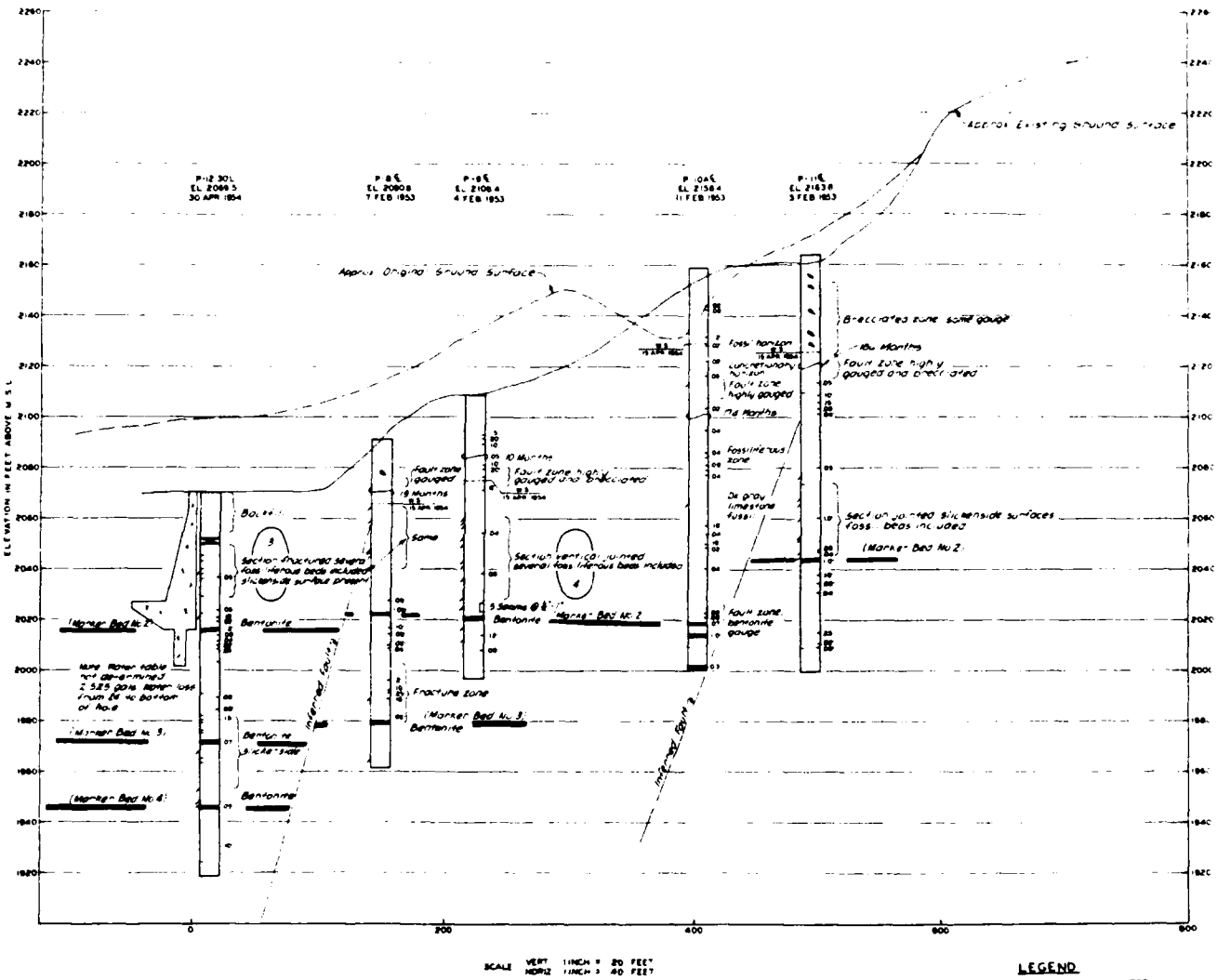
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC PROFILE
P-1 THRU P-5

JULY 1972

CONSTRUCTION FOUNDATION REPORT

PLATE 162

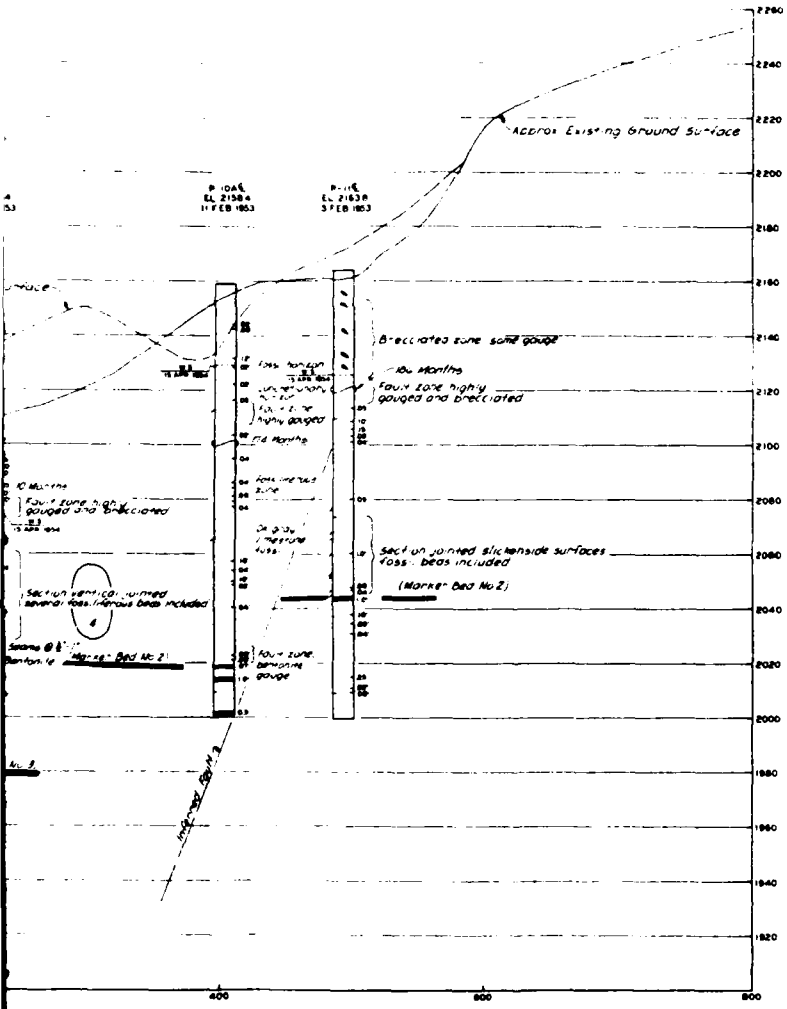
2



SCALE VERT 1 INCH = 20 FEET
HORIZ 1 INCH = 40 FEET

LEGEND

WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
10 MONTHS - RUN BREAK
NO INDICATES THICKNESS



VERT 1 INCH = 20 FEET
HORIZ 1 INCH = 40 FEET

LEGEND

WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
10 MONTHS - PRY BREAK
NO INDICATES THICKNESS IN FEET

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

DIVISIONS

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

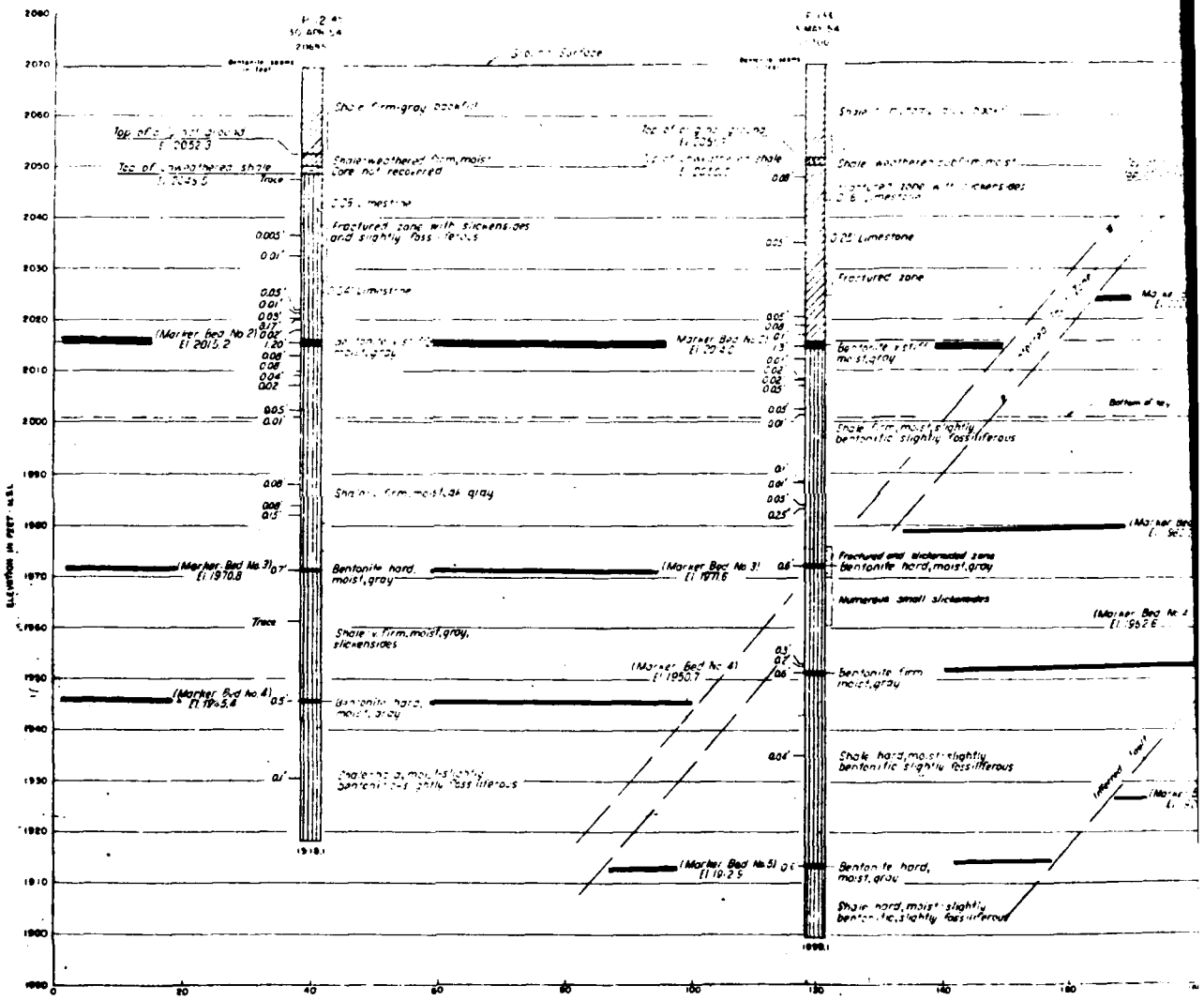
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC PROFILE
P-8 THRU P-11

JULY 1972

SAFETY PAYS

THIS PLAN ACCOMPANIES CONTRACT NO
MODIFICATION NO

CONSTRUCTION FOUNDATION REPORT 2 PLATE 164



LEGEND

P-100 20TR ------ Hole Number and Offset
3 MAY 54 ------ Date Hole completed
2010.0 ------ Elevation Top of Hole

- Weathered Shale
- Core not Recovered
- Minor Fractures
- Sub-firm Shale
- Marker Bed (bentonite)
- Firm Shale
- Minor bentonite seams in feet
- 1990.0 ------ Elevation of bottom of hole

DESCRIPTIVE NOTES

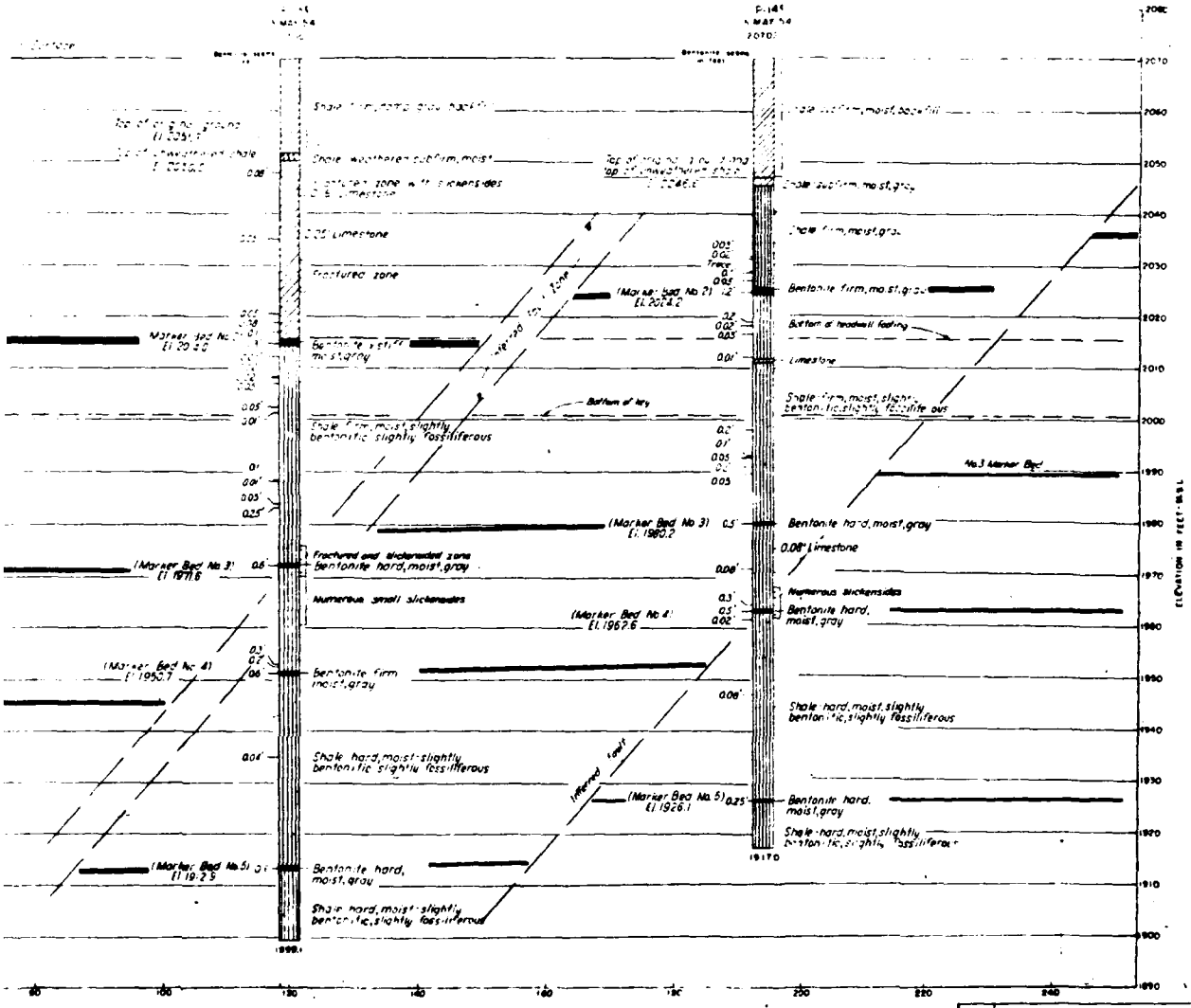
The Bearpaw formation is a dense uniform brush-gray shale containing numerous thin light colored bentonite beds. The shale can be classified into three groups: weathered, sub firm, and firm. The weathered shale has a fissile structure and is composed of small thin soft fragments of shale. The material in the sub-firm group has a shaly to flaggy structure, breaks with an irregular fracture and can be easily scratched with the fingernail. The firm shale has a massive structure, breaks with a conchoidal fracture and can be scratched with a fingernail only with difficulty.

The bentonite beds contain 75% or more clay-like minerals formed by the chemical alteration of volcanic ash beds. The bentonite is fine grained, light in color and has a waxy luster.

Numerous faults of an irregular pattern are present in the Bearpaw in the tunnel outlet area.

SCALE HOR. 1" = 8'
VERT. 1" = 10'

NOTE



SCALE HOR 1" = 8' VERT 1" = 10'

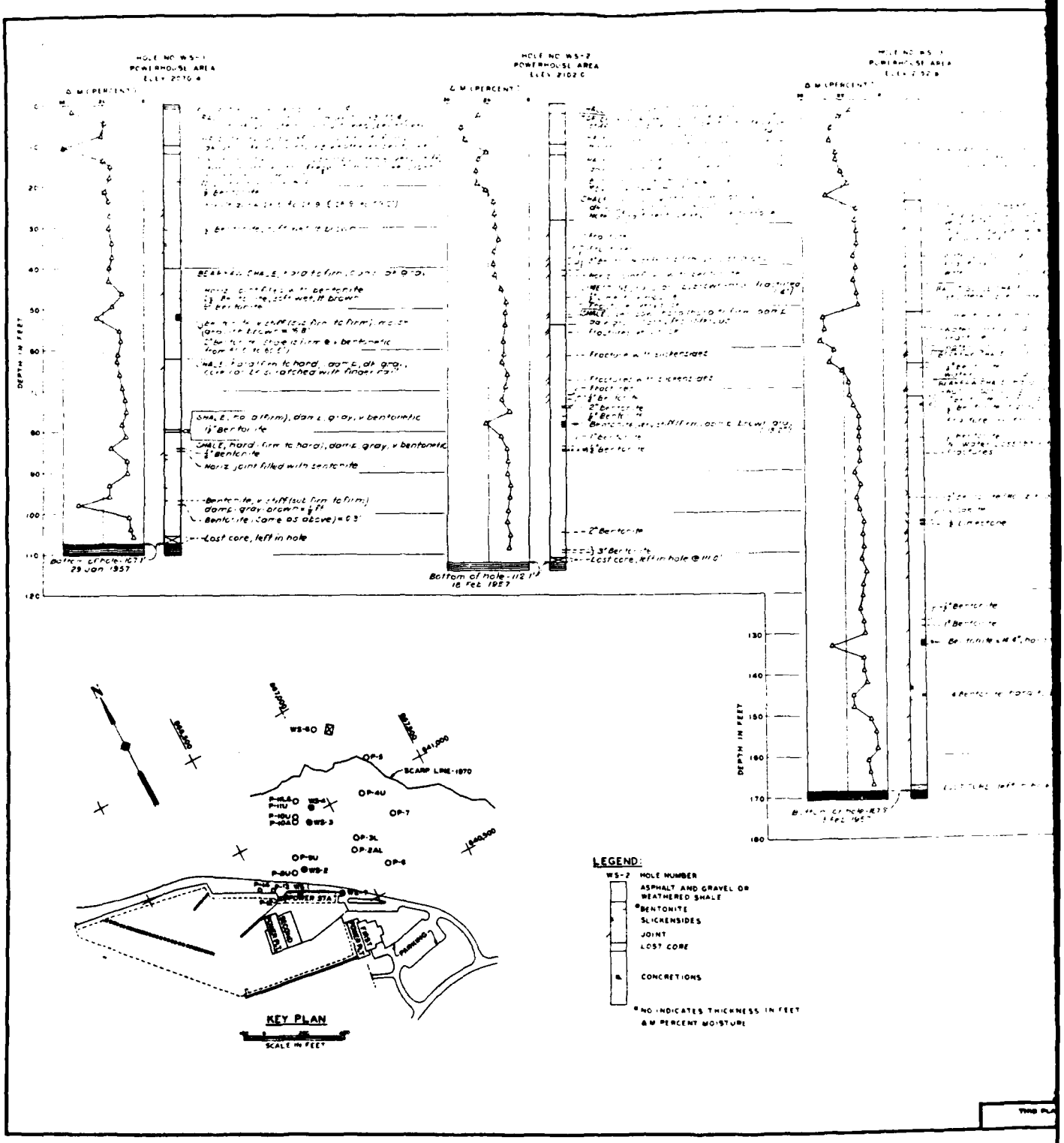
NOTES

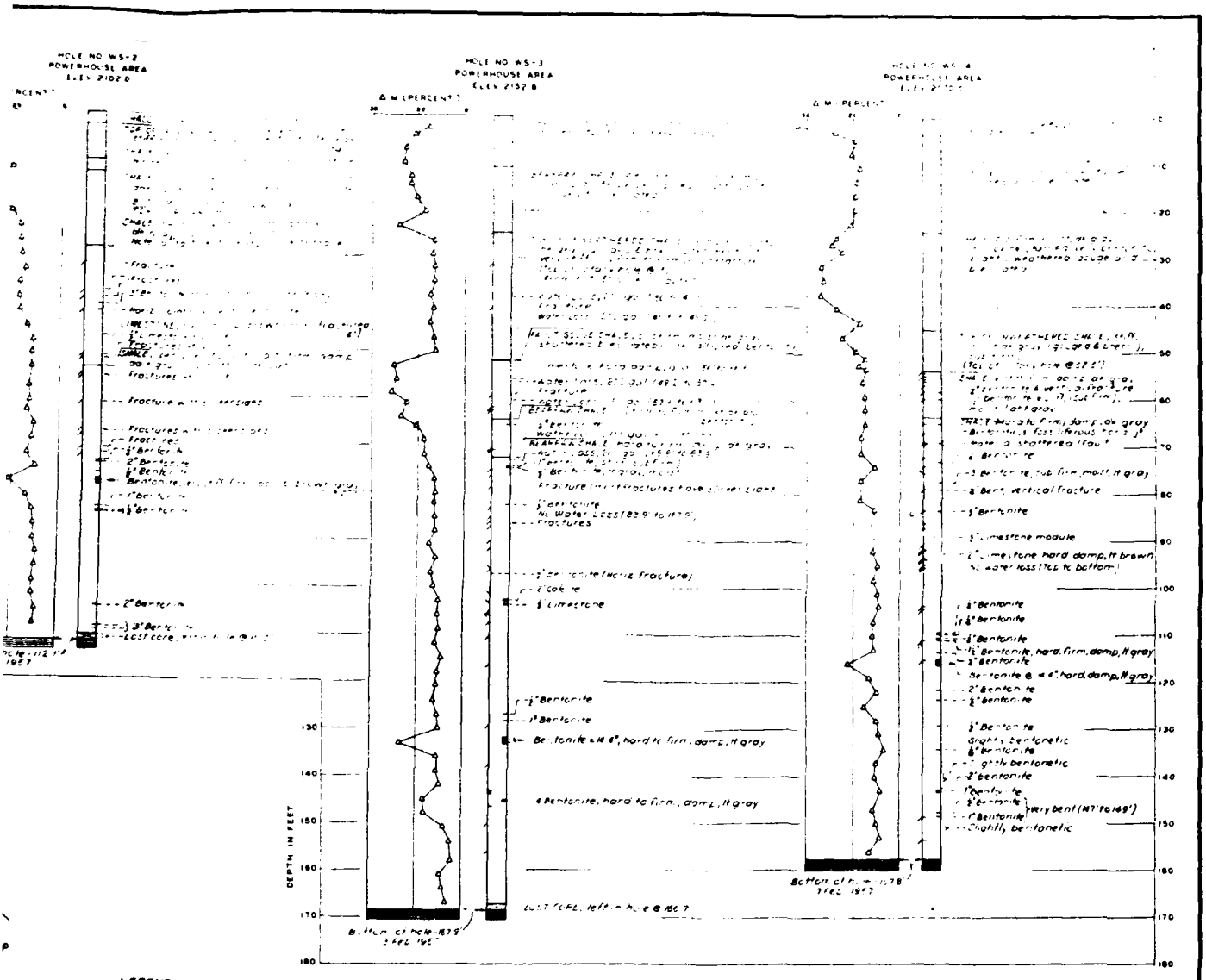
THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

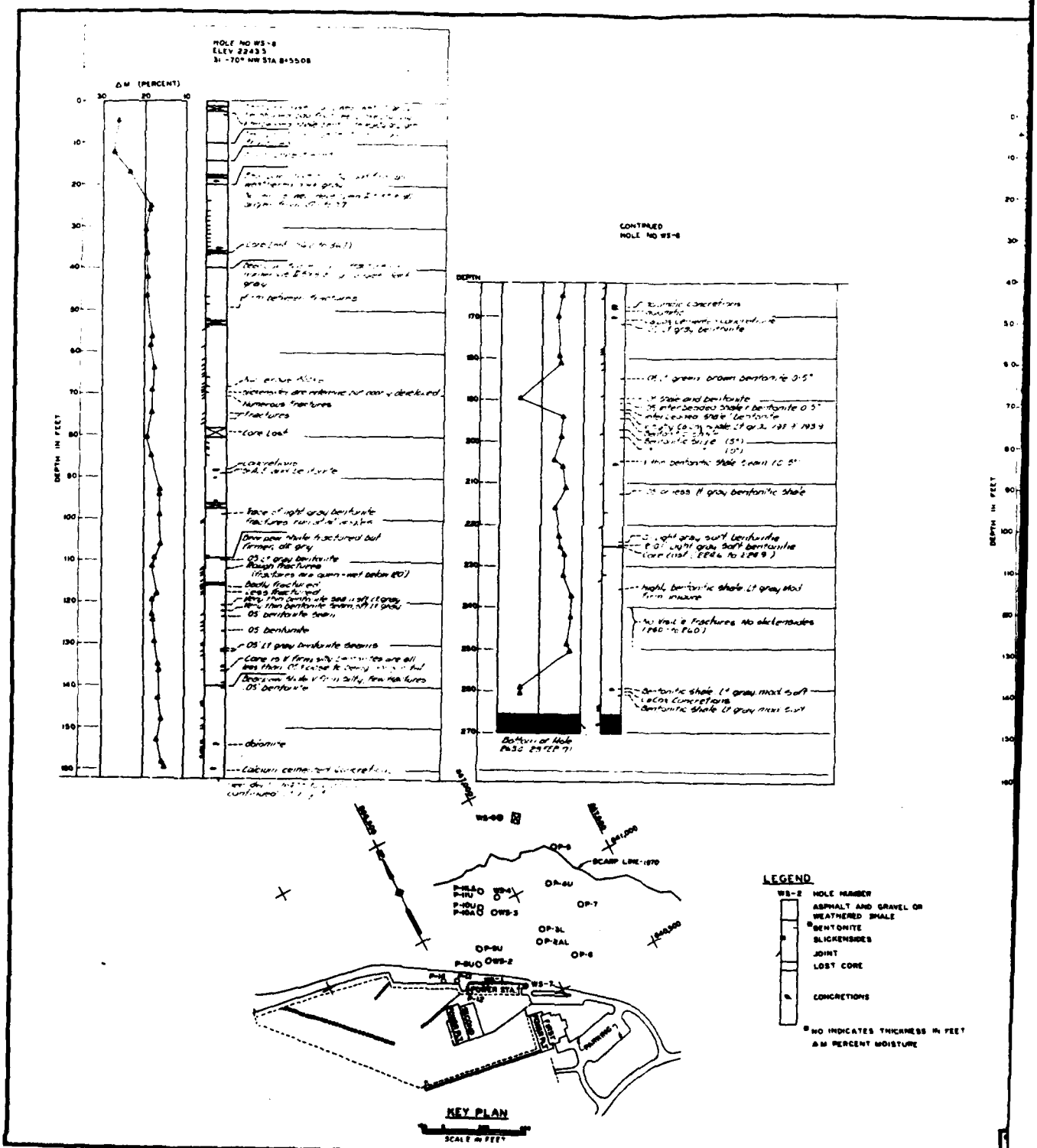
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

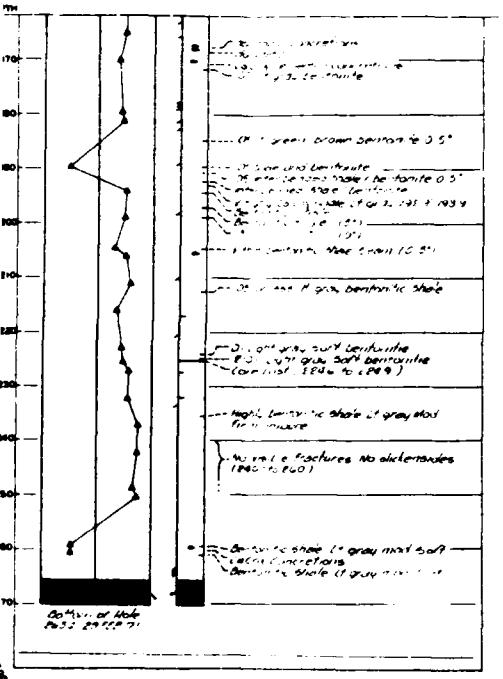
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
GEOLOGIC PROFILE
P-12, P-13 AND P-14

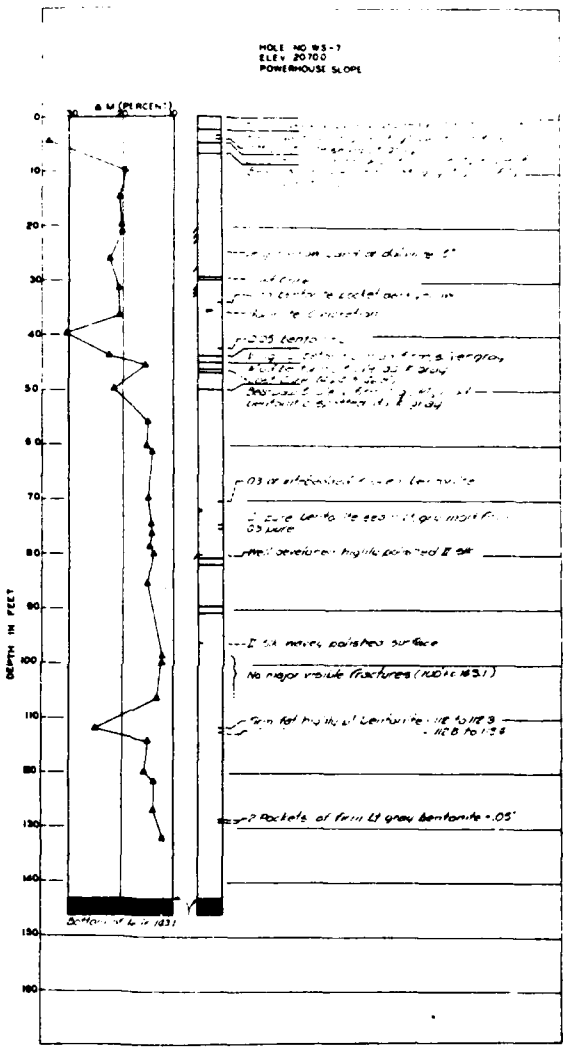
JULY 1972

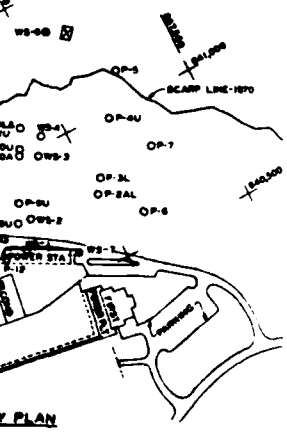

HOLE NO WS-1
POWERHOUSE AREA
ELEV 2070.4
HOLE NO WS-2
POWERHOUSE AREA
ELEV 2102.0
Δ M (PERCENT)
DEPTH IN FEET
Lost core, left in hole
Bottom of hole - 112.1'
18 Feb 1957
Lost core, left in hole @ 111.0'
WS-40
OP-5
SCARP LINE-1870
OP-4U
OP-7
OP-3L
OP-2AL
OP-6
OP-9U
P-9UO
WS-2
WS-3
POWER STA
PARKING
KEY PLAN
SCALE IN FEET
LEGEND:
WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
NO INDICATES THICKNESS IN FEET
Δ M PERCENT MOISTURE


HOLE NO WS-2
POWERHOUSE AREA
HOLE NO WS-3
POWERHOUSE AREA
HOLE NO WS-4
POWERHOUSE AREA
Δ M (PERCENT)
DEPTH IN FEET
LEGEND:
WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
NO INDICATES THICKNESS IN FEET
Δ M PERCENT MOISTURE
THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
LOG OF BORINGS WS-1, WS-2
WS-3 AND WS-4
JULY 1972
SAFETY PAYS


HOLE NO WS-8
ELEV 22435
31 -70° NW STA 8+55.08
ΔM (PERCENT)
DEPTH IN FEET
CONTINUED
HOLE NO WS-8
Bottom of Hole
Feb 32 29 SEP 71
SCARP LINE-1070
POWER STA
LEGEND
WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
NO INDICATES THICKNESS IN FEET
ΔM PERCENT MOISTURE
KEY PLAN
SCALE IN FEET







LEGEND

WS-2 HOLE NUMBER

ASPHALT AND GRAVEL OR WEATHERED SHALE

BENTONITE

SLICKENSIDES

JOINT

LOST CORE

CONCRETIONS

NO INDICATES THICKNESS IN FEET

& M PERCENT MOISTURE

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

DATE	DESCRIPTION	DRAWN	APPROVED

REVISIONS

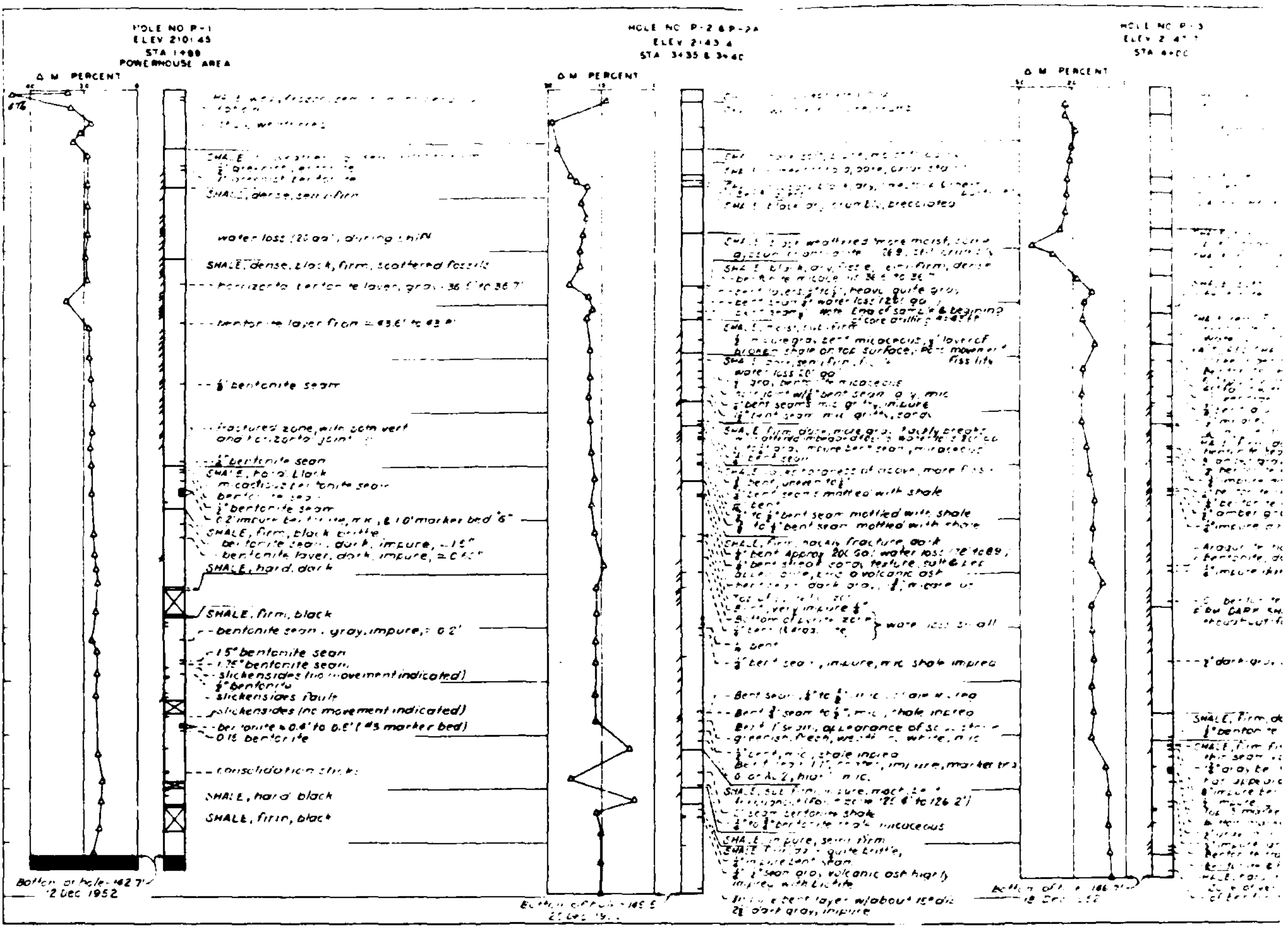
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER

FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
LOG OF BORINGS WS-6 & WS-7

DATE: JULY 1972

THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

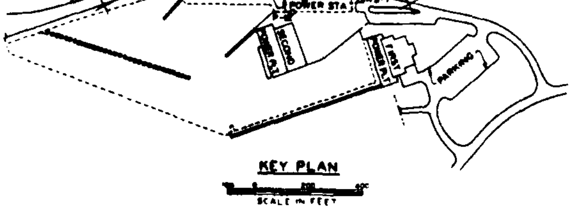


LEGEND

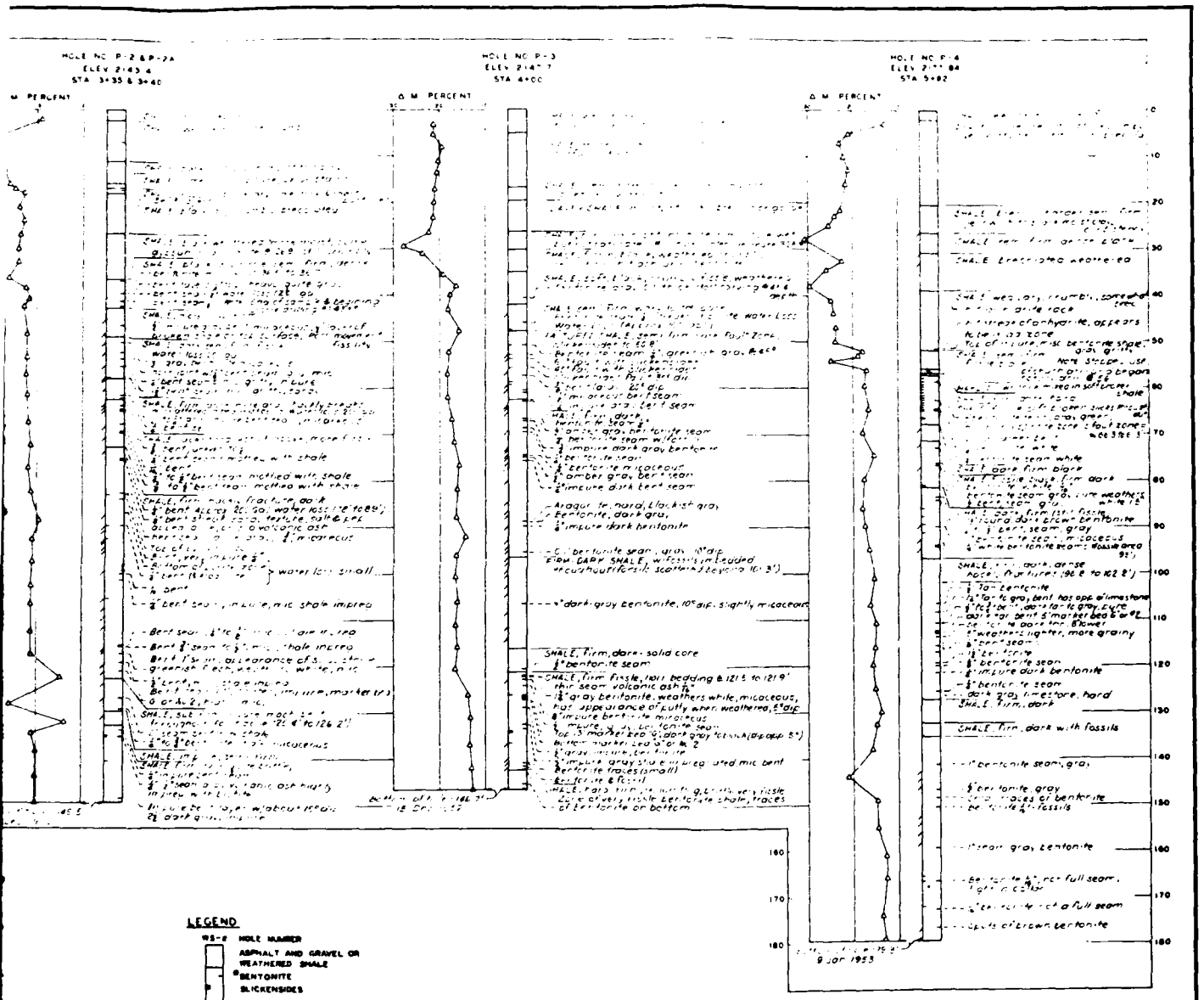
- WS-2 HOLE NUMBER
- ASPHALT AND GRAVEL OR WEATHERED SHALE
- *BENTONITE
- SLICKENSIDES
- JOINT
- LOST CORE
- CONCRETIONS

*NO INDICATES THICKNESS IN FEET

Δ M PERCENT MOISTURE



KEY PLAN



LEGEND

WS-2 HOLE NUMBER

ASPHALT AND GRAVEL OR WEATHERED SHALE

*BENTONITE

SLICKENSIDES

JOINT

LOST CORE

CONCRETIONS

*NO INDICATES THICKNESS IN FEET

Δ M PERCENT MOISTURE

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

SAFETY PAYS

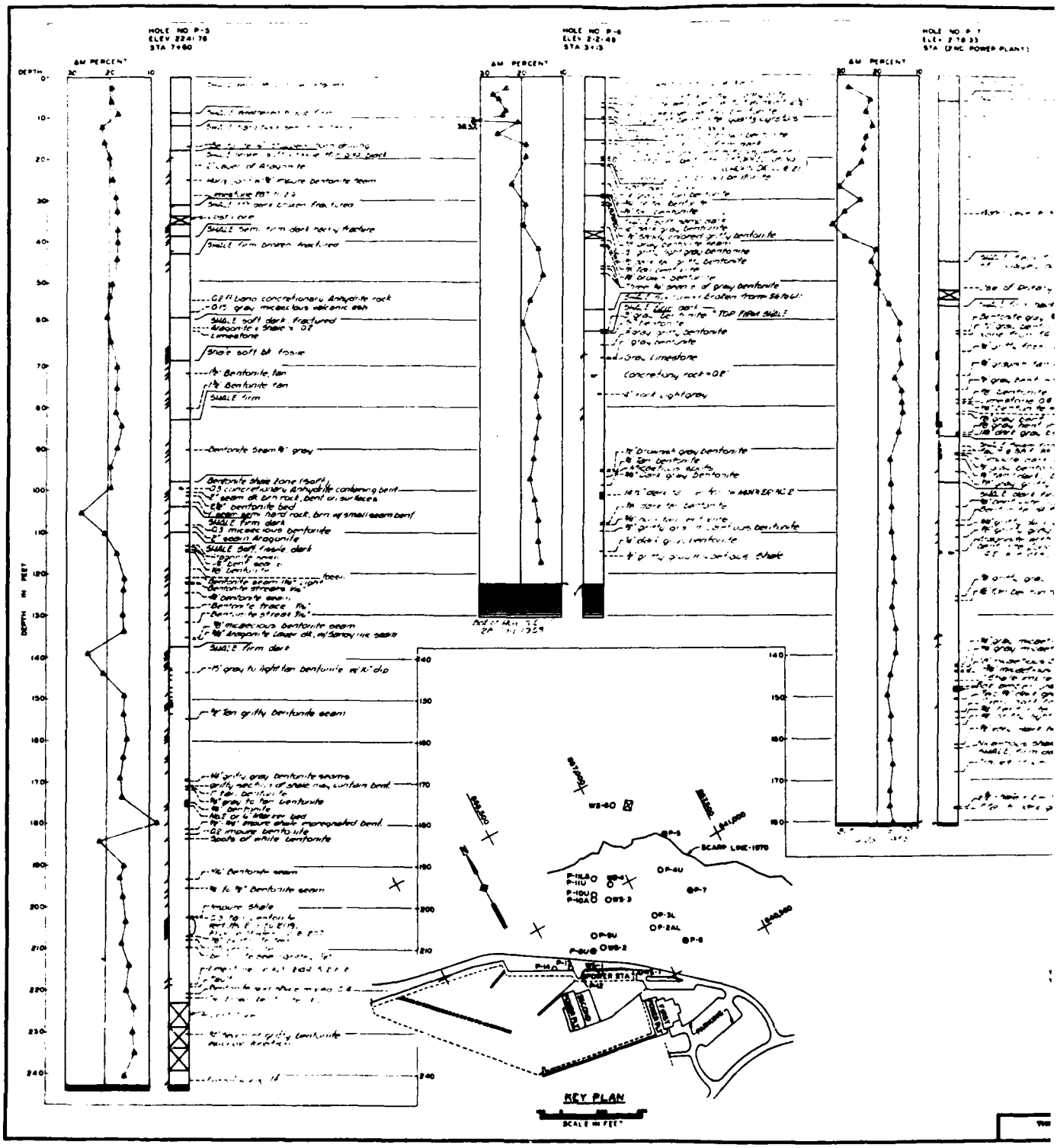
THIS PLAN ACCOMPANIES CONTRACT NO
MODIFICATION NO

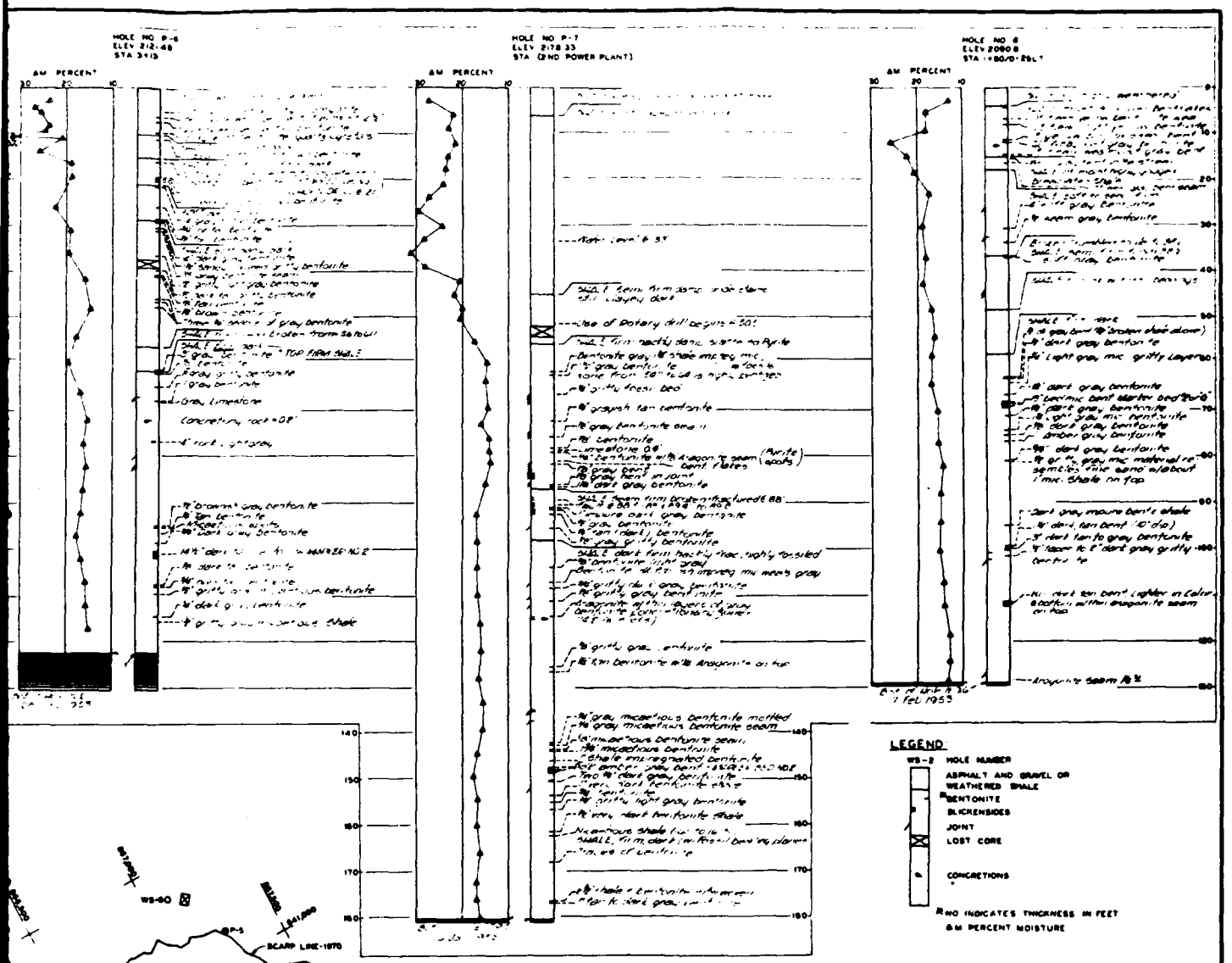
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

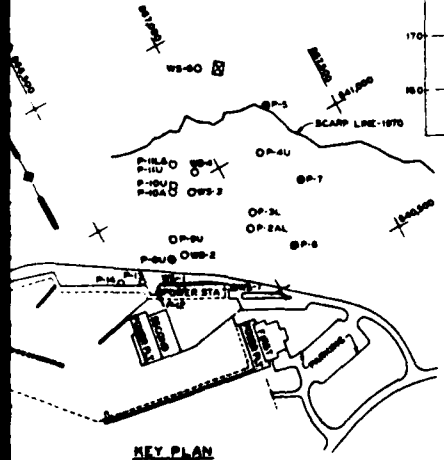
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
LOG OF BORINGS P-1, P-2 & 2A, P-3 & P-4

JULY 1972

CONSTRUCTION FOUNDATION REPORT 2 PLATE 168


HOLE NO P-3
ELEV 2241.76
STA 7+60
HOLE NO P-6
ELEV 2121.48
STA 3+13
HOLE NO P-7
ELEV 2176.33
STA (PMC POWER PLANT)
BM PERCENT
DEPTH IN FEET
SHALE soft dark fractured
Bentonite Seam 1/8" gray
SHALE Firm dark
Limestone
Concretionary rock = 0.8'
TOP FIRM SHALE
SCARP LINE-1970
POWER STA
KEY PLAN
SCALE IN FEET





THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

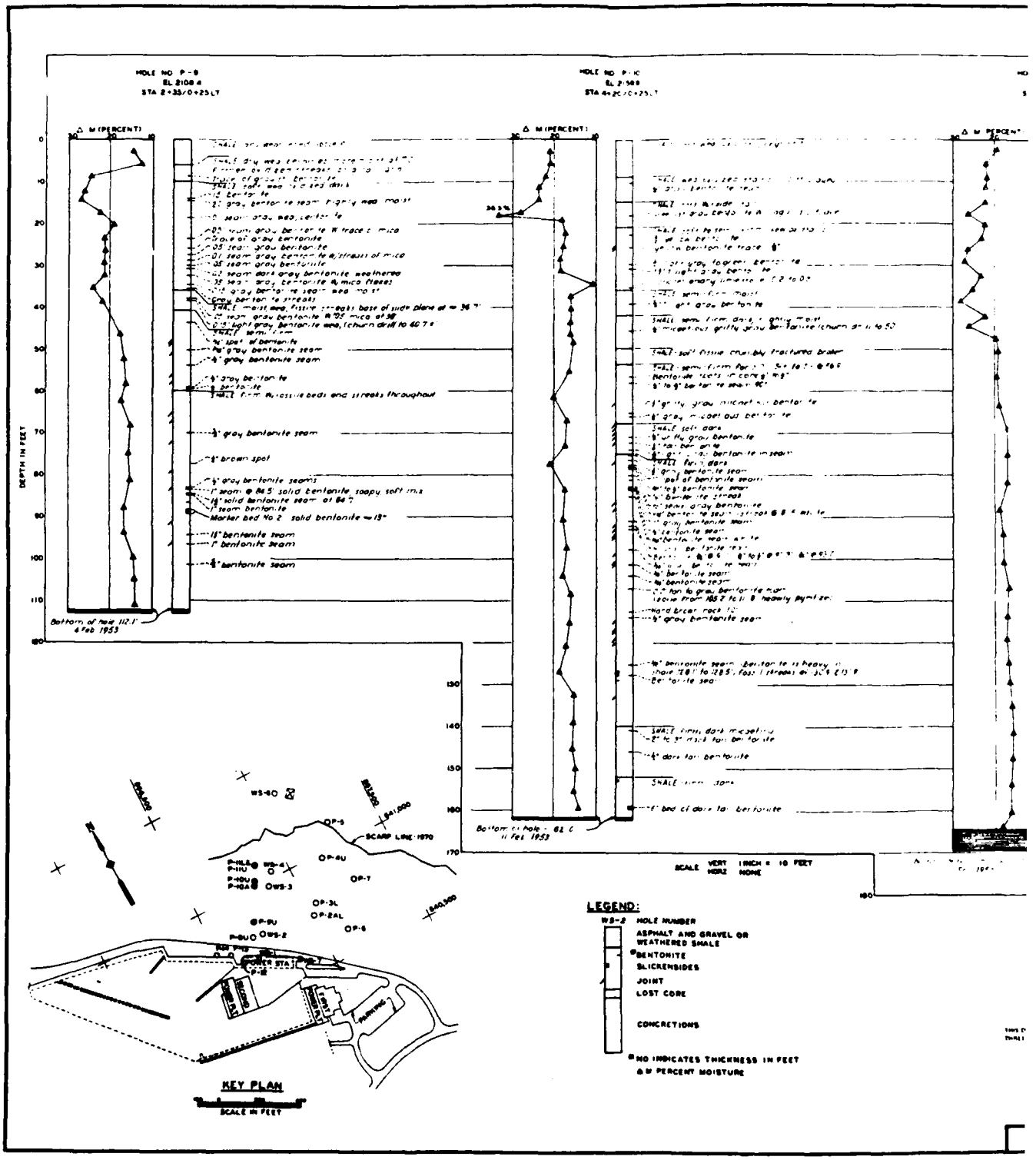
SAFETY PAYS

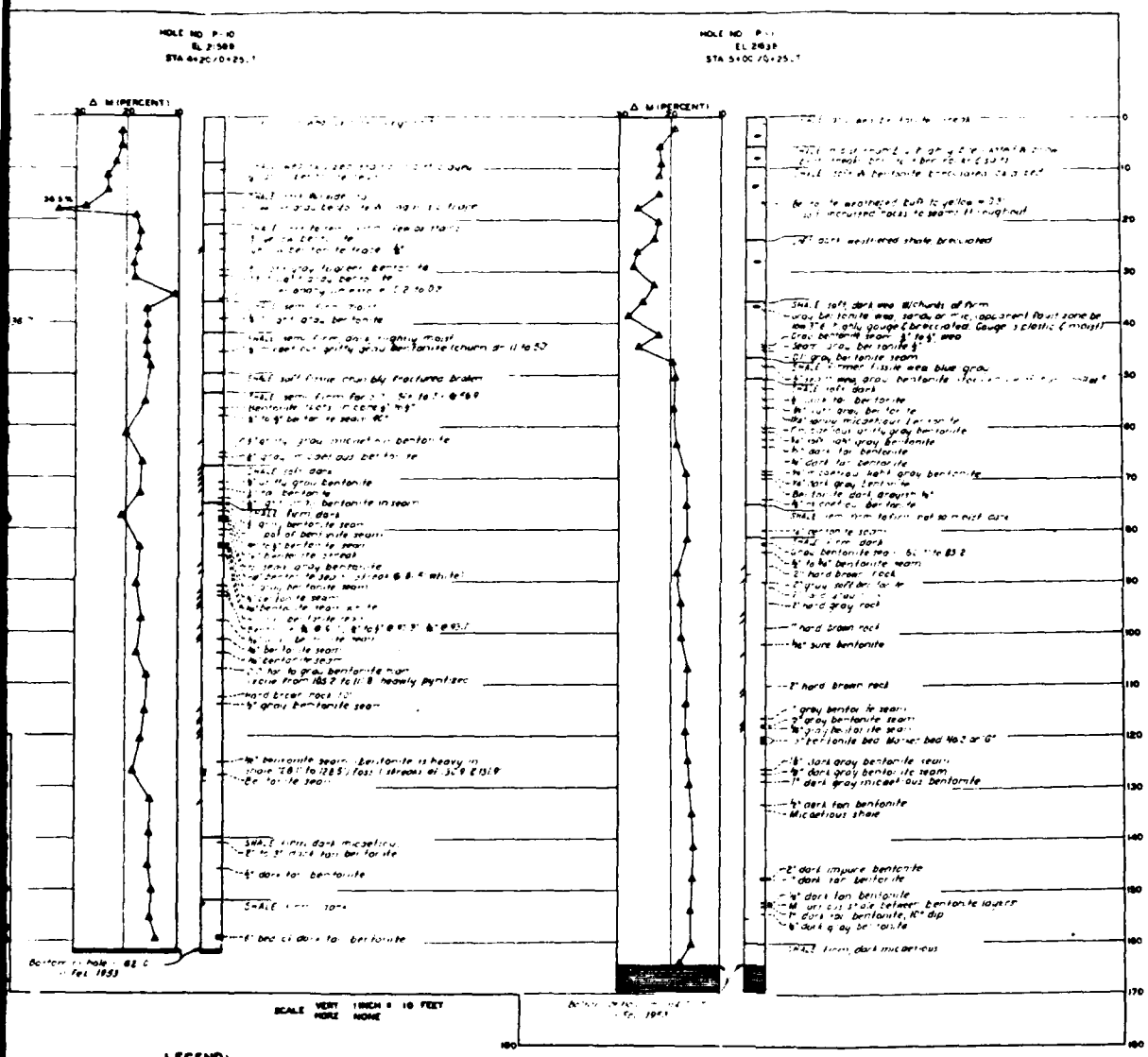
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
LOG OF BORINGS P-5, P-6
P-7 AND P-8

JULY 1972

THIS PLAN ACCOMPANIES SENTRACT NO.
MODIFICATION NO.


HOLE NO P-9
EL 2108.4
STA 2+35/0+25 LT
HOLE NO P-10
EL 2109
STA 4+20/0+25 LT
Δ M (PERCENT)
DEPTH IN FEET
Bottom of hole 112.1'
4 Feb 1953
Bottom of hole - 82.0'
11 Feb 1953
SCALE VERT 1 INCH = 10 FEET
HORZ NONE
LEGEND:
WS-2 HOLE NUMBER
ASPHALT AND GRAVEL OR WEATHERED SHALE
BENTONITE
SLICKENSIDES
JOINT
LOST CORE
CONCRETIONS
NO INDICATES THICKNESS IN FEET
Δ M PERCENT MOISTURE
SCARP LINE 1970
POWER STA
PARKING
KEY PLAN
SCALE IN FEET



LEGEND:

WS-2 HOLE NUMBER

ASPHALT AND GRAVEL OR WEATHERED SHALE

BENTONITE

SLICKENSIDES

JOINT

LOST CORE

CONCRETIONS

NO INDICATES THICKNESS IN FEET

M PERCENT MOISTURE

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

SAFETY PAYS

THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

REVISIONS

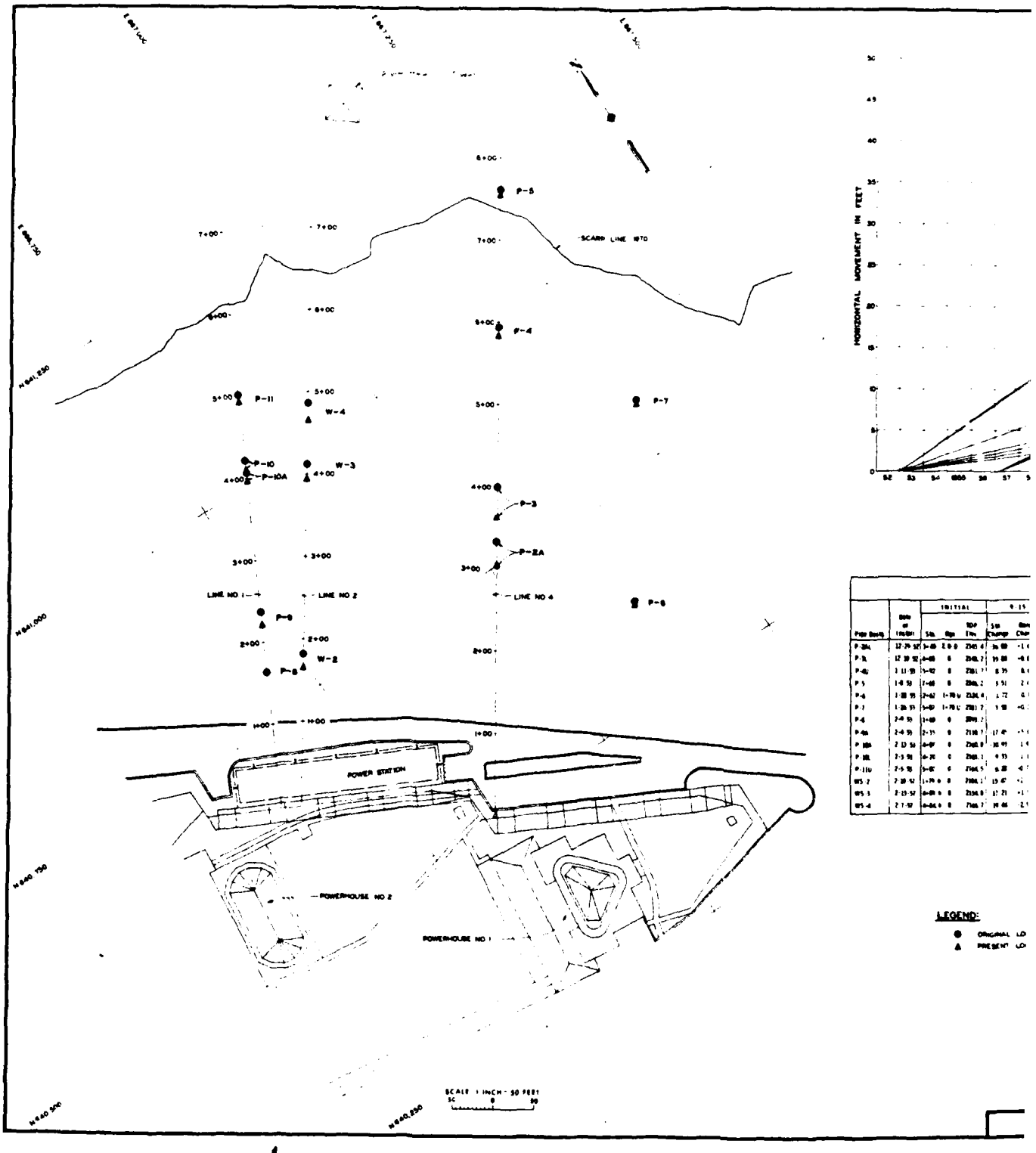
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

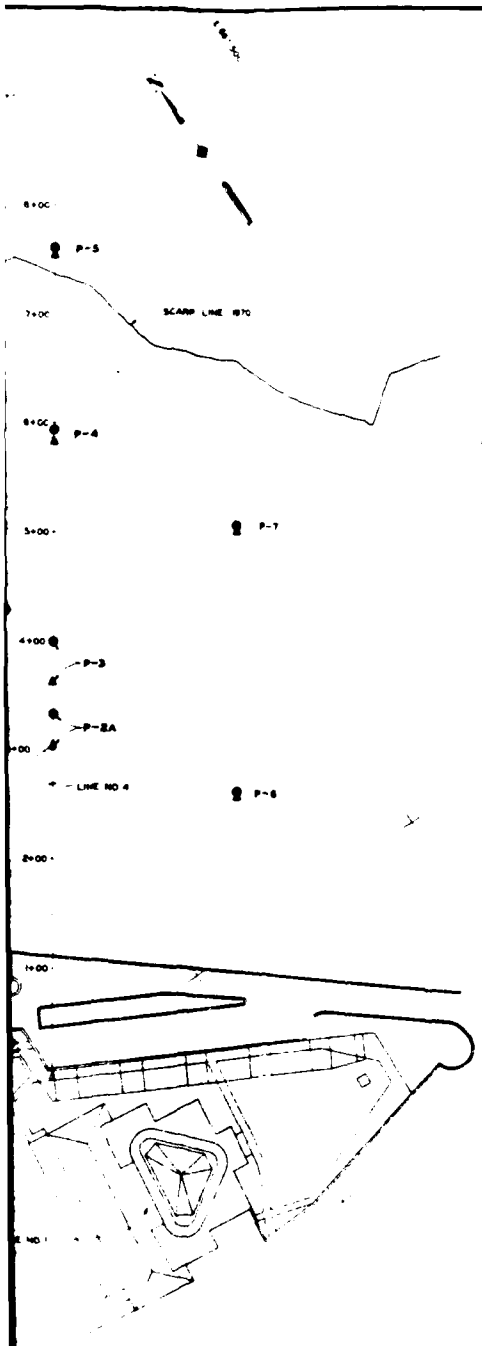
MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
LOG OF BORING
P-9, P-10 AND P-11

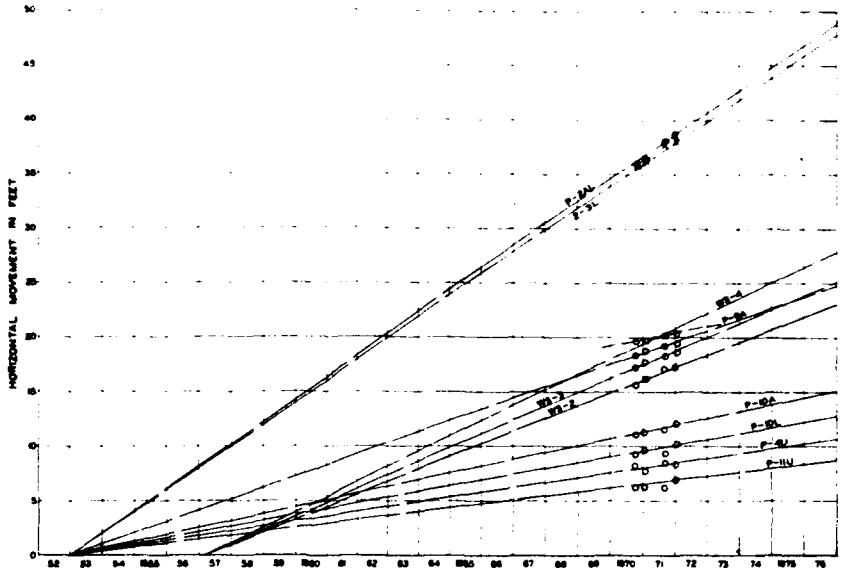
JULY 1972

CONSTRUCTION FOUNDATION REPORT 2

PLATE 170


SCARP LINE NO
P-5
P-4
P-11
W-4
P-7
P-10
P-10A
W-3
P-3
P-2A
LINE NO 1
LINE NO 2
LINE NO 4
P-6
P-9
W-2
P-8
POWER STATION
POWERHOUSE NO 2
POWERHOUSE NO 1
SCALE 1 INCH = 50 FEET
HORIZONTAL MOVEMENT IN FEET
LEGEND:
ORIGINAL LO
PRESENT LO





SUMMARY TABULATION

FORT PECK POWERHOUSE SLOPE
MOVEMENT OBSERVATIONS - PIEZOMETER & TILTMETERS

Pipe Desig	Date of Install	INITIAL Sta.	INITIAL Bgs.	INITIAL TOP Elev	9-15-70 OBS Sta Change	9-15-70 OBS Bmgr Change	9-15-70 OBS TOP Change	9-15-70 OBS Result. Horiz Movement	12-18-70 OBS Sta Change	12-18-70 OBS Bmgr Change	12-18-70 OBS TOP Change	12-18-70 OBS Result. Horiz. Movement	7-26-71 OBS Sta Change	7-26-71 OBS Bmgr Change	7-26-71 OBS TOP Change	7-26-71 OBS Result. Horiz. Movement	7-26-71 OBS Result. Movement Rate Per Yr.	12-2-71 OBS Sta Change	12-2-71 OBS Bmgr Change	12-2-71 OBS TOP Change	12-2-71 OBS Result. Horiz. Movement	12-2-71 OBS Result. Movement Rate Per Yr.
P-2AL	12-29-52	3+00	2.0-D	2165.4	-36.00	+1.67 D	-2.9	-36.04	-36.39	+1.00 D	-3.0	36.44	-38.04	+2.00 D	-3.0	-38.09	2.00'	-38.39	+2.11 D	-3.25	-38.55	2.00'
P-3L	12-30-52	4+00	0	2148.7	-35.00	+4.25 D	-4.7	-35.81	-36.12	+1.67 D	-4.5	36.13	-37.00	+4.90 D	-4.6	-37.44	2.00'	-37.97	+1.83 D	-4.07	-37.99	2.00'
P-4U	3-11-53	5+92	0	2181.1	0.35	-0.00 U	-1.5	-0.35	-7.05	+0.75 D	-1.6	-7.06	-0.94		-1.6		0.00'	-0.00		-1.50		0.00'
P-5	1-8-53	7+00	0	2144.2	3.51	-2.00 U	-	-4.27	-3.34	-2.20 U	-	-3.92	-3.40	-2.00		-4.21	0.25'	3.32	-2.20 U	-4.72	-4.05	0.21'
P-6	2-20-53	2+62	1+70 U	2134.4	-1.72	-0.10 U	0	-1.72	-0.96	-0.00 U	+0.10	0.96	-1.94	-0.14 U	+0.1	-1.75	0.00	-1.02	-0.40 U	+0.05	-1.02	0.00'
P-7	1-26-53	5+00	1+70 U	2181.2	-3.90	+0.21 D	0	-3.90	-3.05	+0.27	+0.01	-3.06	-3.54	+0.10 D	0	-3.55	0.10'	-3.54	+0.25 D	+0.04	-3.52	0.10'
P-8	2-4-53	1+00	0	2095.2																		
P-4A	2-4-53	2+55	0	2170.7	-17.05	+5.00 D	-3.7	-18.39	-17.01	+3.90 D	-3.9	-18.77	-16.25	+4.30 D	-4.1	-19.34	1.00'	-16.40	+4.20 D	-4.30	-19.40	1.00'
P-10A	2-13-53	0+07	0	2160.8	-10.99	1.00 U	-3.4	-11.00	-11.30	-1.00 U	-3.4	-11.30	-11.35	-1.00 U	-3.4	-11.51	0.00'	-11.97	-1.00 U	-3.40	-12.13	0.00'
P-10L	2-5-53	0+20	0	2160.1	-9.33	-1.13 U	-4.6	-9.40	-9.00	-1.00 U	-4.7	-9.34	-9.37	-1.11 U	- 7	-9.40	0.51'	-10.20	-1.00 U	-4.60	-10.26	0.50'
P-11U	2-5-53	3+00	0	2164.5	-6.20	-0.75 U	-1.9	-6.32	-6.31	-0.50 U	-2.1	-6.35	-6.14	-0.00 U	-2.1	-6.18	0.35'	6.95	-0.70 U	-2.15	-6.97	0.37'
WS-2	2-20-53	1+79 D	0	2184.1	-15.07	+2.71 D	-3.4	-15.71	-16.06	+2.00 D	-3.8	-16.33	-16.79	+3.05 D	-4.1	-17.06	0.07'	-17.00	+3.20 D	-4.00	-17.30	0.07'
WS-3	2-13-53	0+00 D	0	2134.8	-17.21	+1.30 D	-3.3	-17.20	-17.75	+1.30 D	-3.6	-17.84	-18.30	+1.30 D	3.6	-18.30	0.00'	-18.46	+1.05 D	-4.00	-18.55	0.00'
WS-4	2-7-53	0+04 D	0	2166.7	-19.00	-2.50 U	-2.7	-19.04	-19.55	-2.00 U	-1.9	-19.73	-20.34	-2.00 U	-2.0	-20.70	1.00	-20.34	-2.50 U	-0.02	-20.40	1.00'

THIS DRAWING HAS BEEN REDUCED TO THREE EIGHTHS THE ORIGINAL SCALE

LEGEND:

- ● ORIGINAL LOCATION
- ▲ PRESENT LOCATION

DATE	DESCRIPTION	CHKD	APPRD

REVISIONS

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK LAKE, MONTANA
POWERHOUSE SLOPE EXCAVATION
SLIDE MOVEMENT OBSERVATIONS
PIEZOMETERS AND TILTMETERS

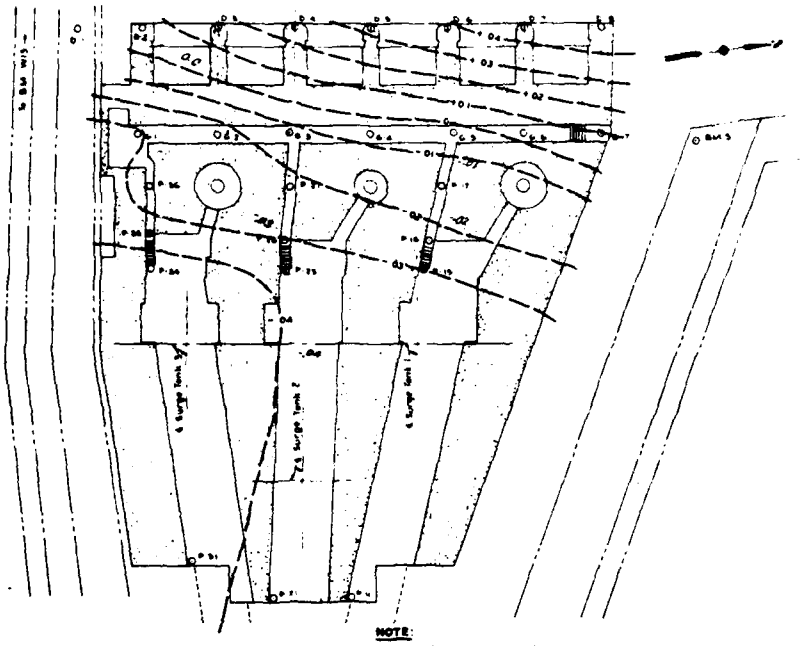
DESIGNED BY: G. H.
DRAWN BY: W. D.
CHECKED BY: C. Y.
SUBMITTED BY: J. H. Nelson
CHIEF, DIV. OF DESIGN
RECOMMENDED: J. H. Lang
CHIEF, DIV. OF DESIGN
APPROVED: Kenneth D. Carlson
CHIEF, ENGINEERING DIV.

DATE: JULY 1972
SCALE AS SHOWN
DWG NO.
REVISED DRAWING
DATE:

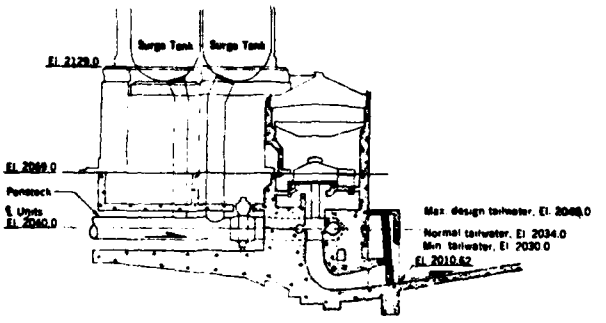
SAFETY PAYS

THIS PLAN ACCOMPANIES CONTRACT NO
MODIFICATION NO

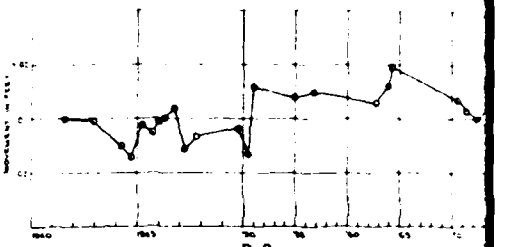
CONSTRUCTION FOUNDATION REPORT 2 PLATE 171

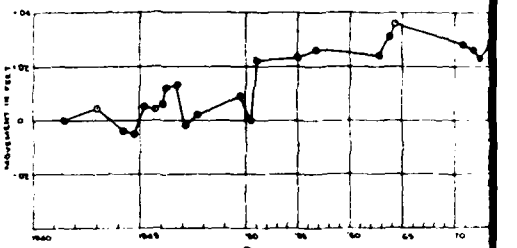


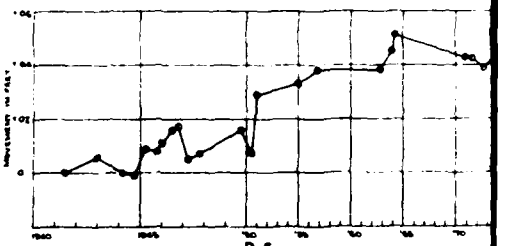
PLAN

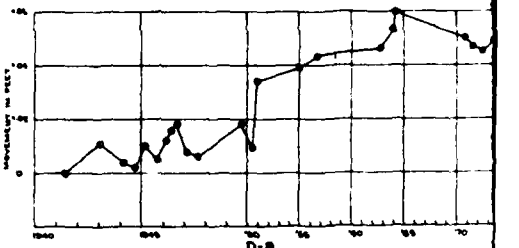


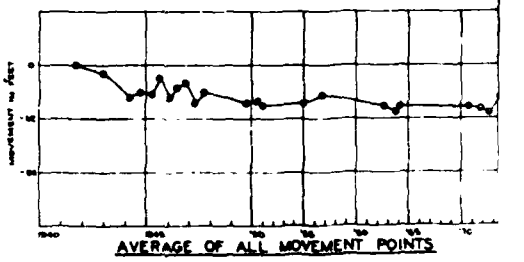
POWERHOUSE SECTION
FIRST POWER PLANT



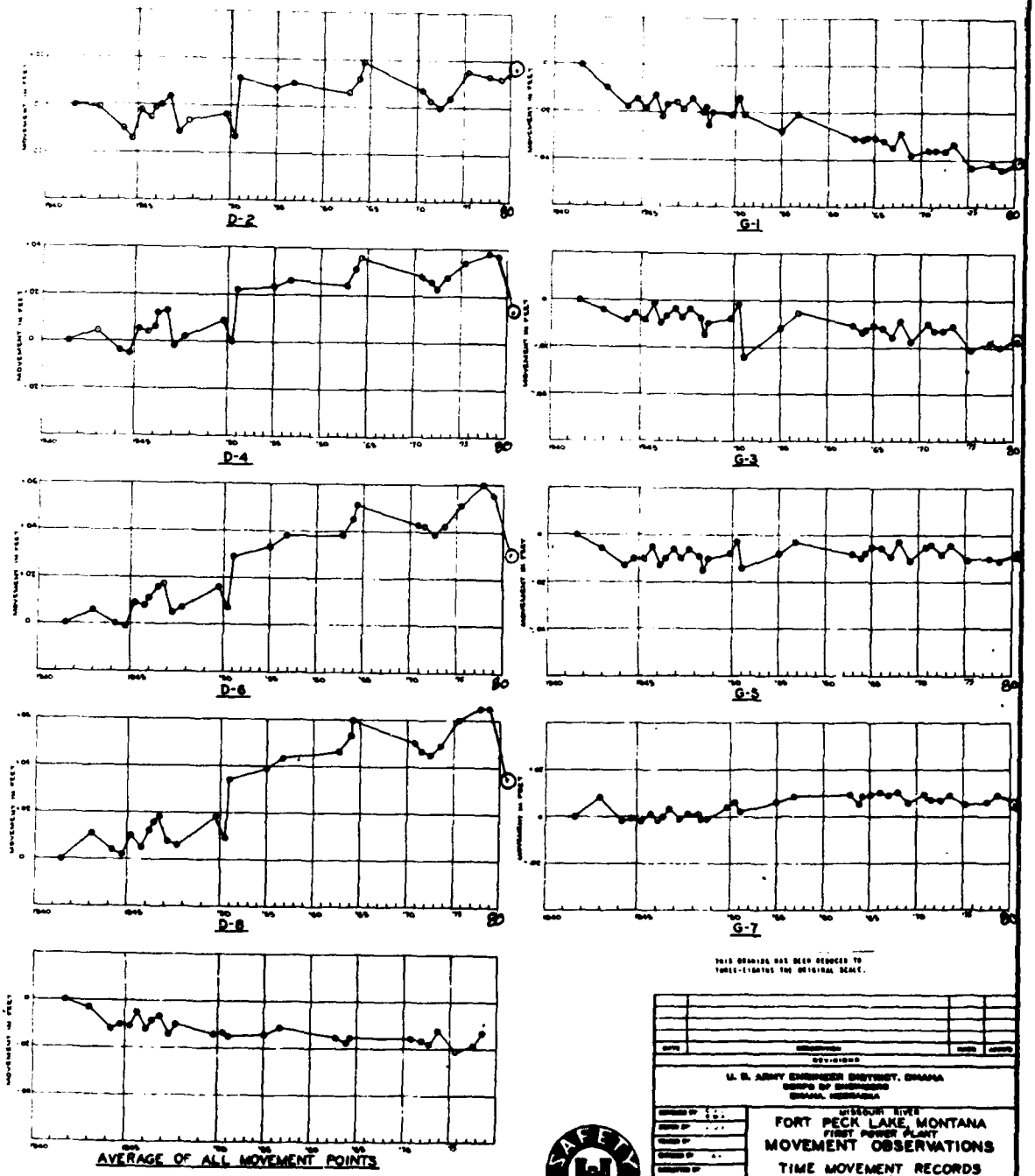








AVERAGE OF ALL MOVEMENT POINTS



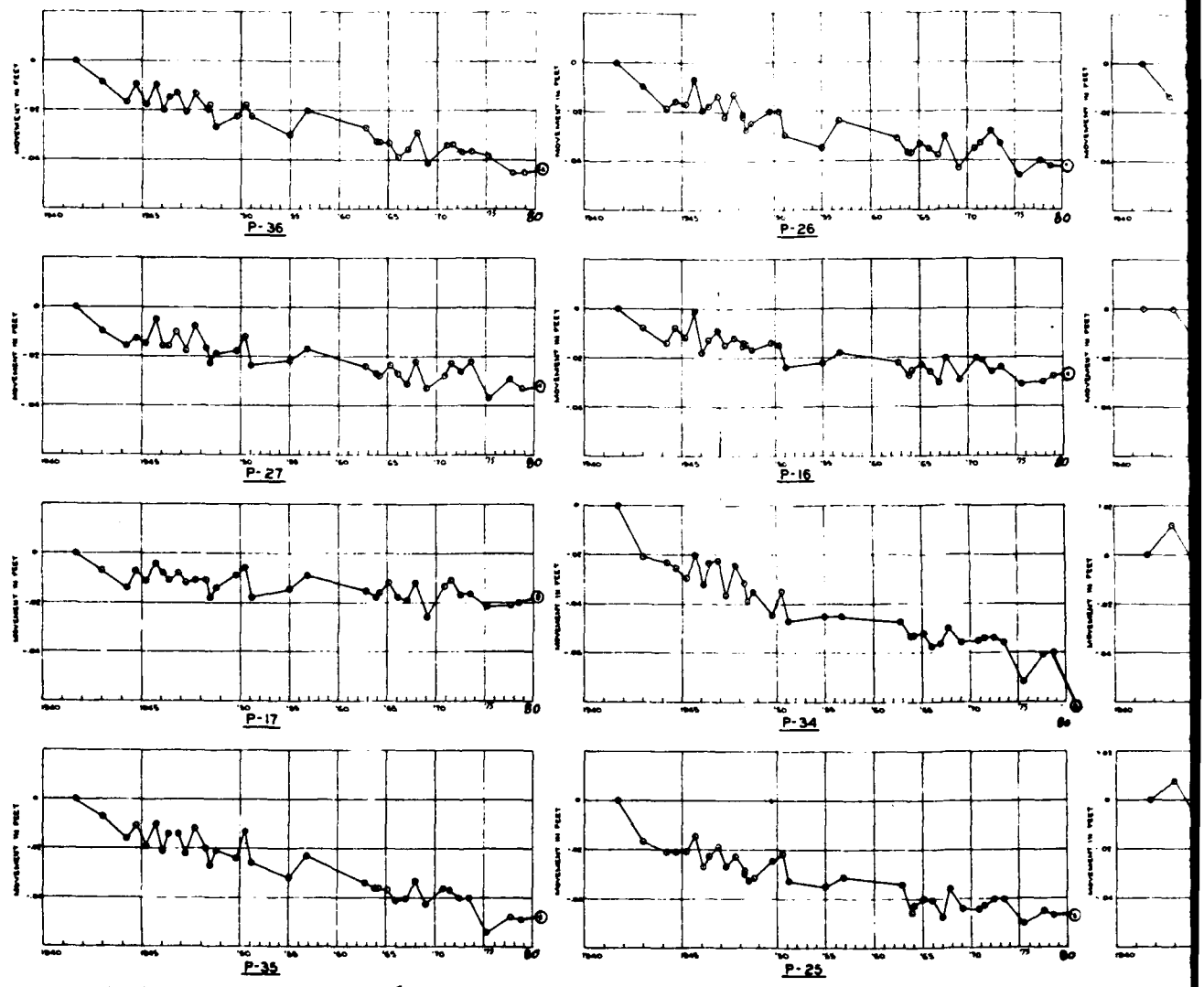
THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE.

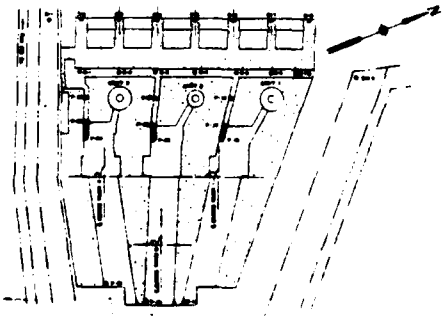
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK LAKE, MONTANA
FIRST POWER PLANT
MOVEMENT OBSERVATIONS
TIME MOVEMENT RECORDS
SHEET 1 OF 2

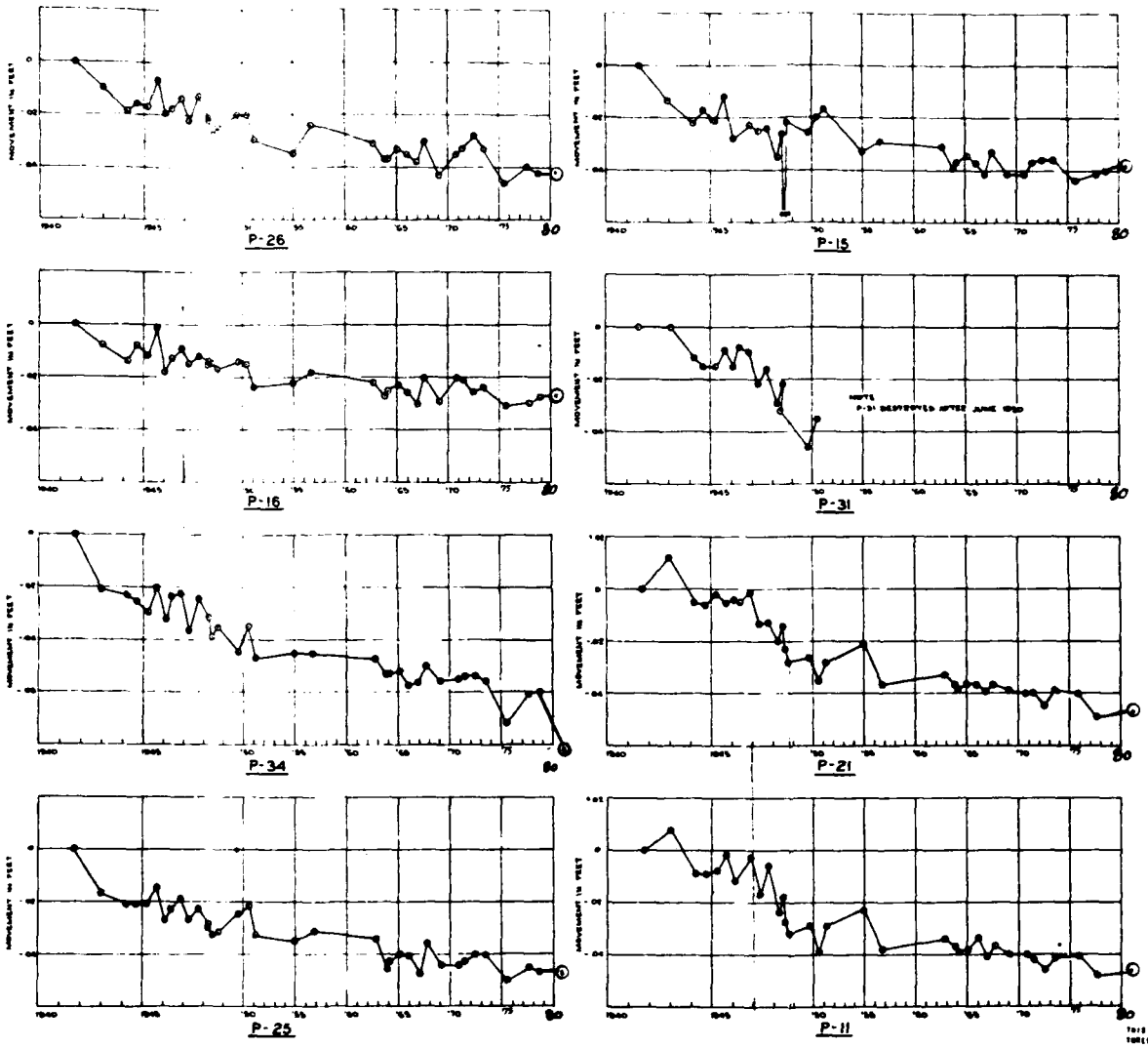
SAFETY DAYS

2





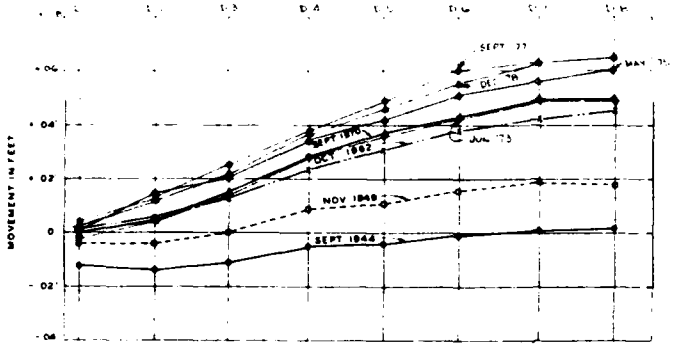
KEY PLAN

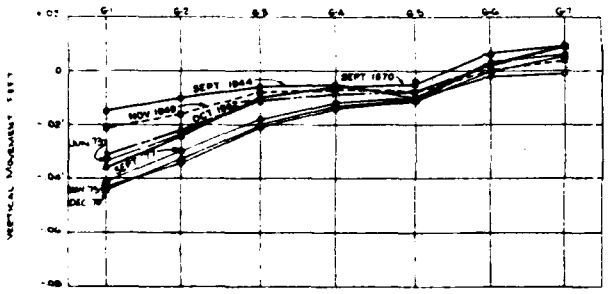


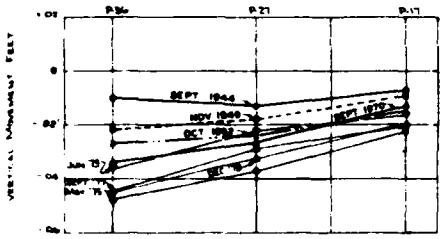
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

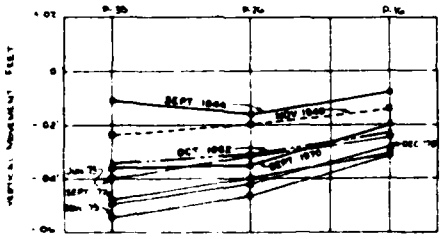
MISSOURI RIVER
FORT PECK LAKE, MONTANA
FIRST POWER PLANT
MOVEMENT OBSERVATIONS
TIME MOVEMENT RECORDS
SHEET 2 OF 2

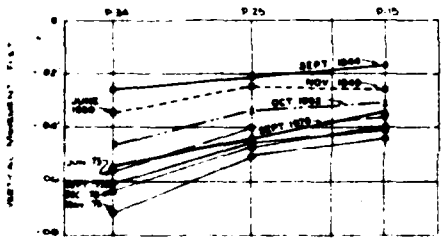
SAFETY PAYS

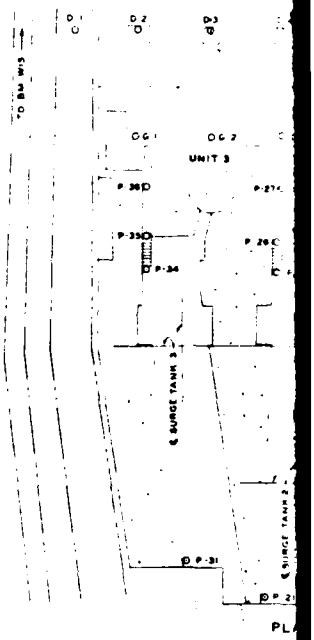

MOVEMENT IN FEET
SEPT 1944
NOV 1949
OCT 1952
SEPT 1970
JUN 73
MAY 75

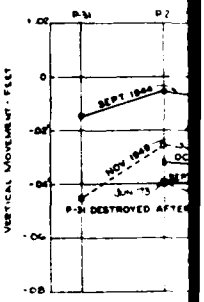

VERTICAL MOVEMENT FEET
SEPT 1944
NOV 1949
OCT 1952
SEPT 1970
JUN 73
SEPT 75
MAY 75
DEC 76

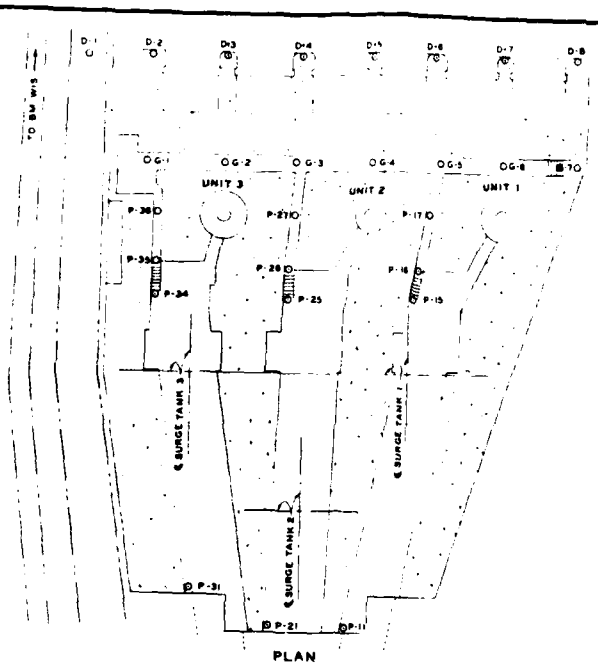

VERTICAL MOVEMENT FEET
P-36
P-27
P-17
SEPT 1944
NOV 1949
OCT 1952
SEPT 1970
JUN 73
SEPT 75
MAY 75
DEC 76


VERTICAL MOVEMENT FEET
P-35
P-26
P-16
SEPT 1944
NOV 1949
OCT 1952
SEPT 1970
JUN 73
SEPT 75
MAY 75
DEC 76

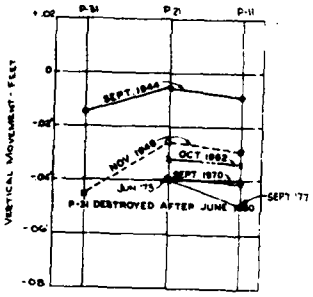

VERTICAL MOVEMENT FEET
P-34
P-25
P-15
SEPT 1944
NOV 1949
OCT 1952
SEPT 1970
JUN 73
DEC 76
MAY 75


UNIT 3
P-36
P-33
P-34
P-31
SURGE TANK 3
SURGE TANK 2


VERTICAL MOVEMENT - FEET
P-31
SEPT 1944
NOV 1949
JUN 73
P-31 DESTROYED AFTER



PLAN



THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE.

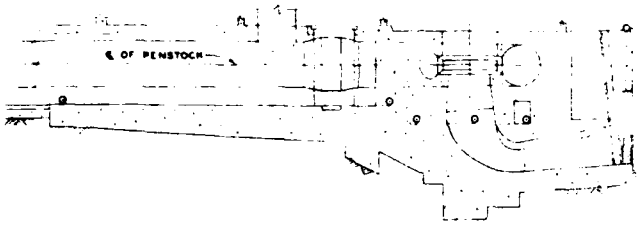
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK LAKE, MONTANA
FIRST POWER PLANT
MOVEMENT OBSERVATIONS
SUMMARY OF TILT, UNITS 1,2 & 3
SHEET 1

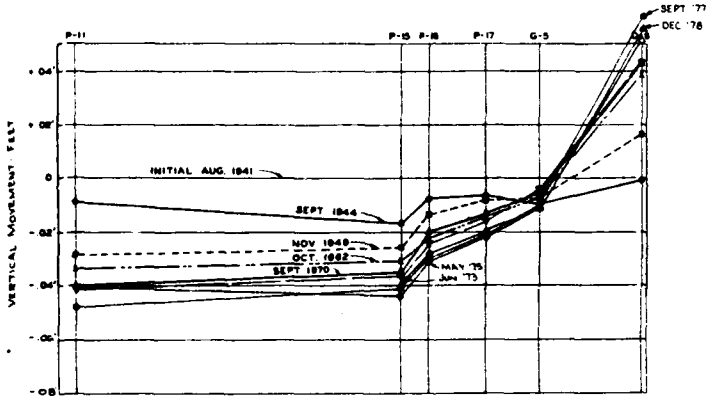
SAFETY DAYS

THIS PLAN ACCOMPANIES DENTRACT NO.
MODIFICATION NO.

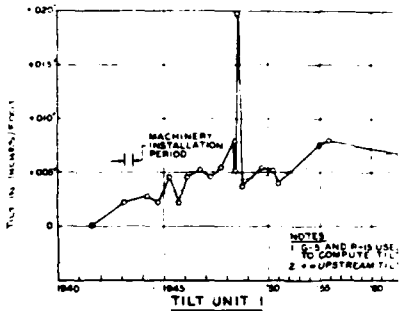
2



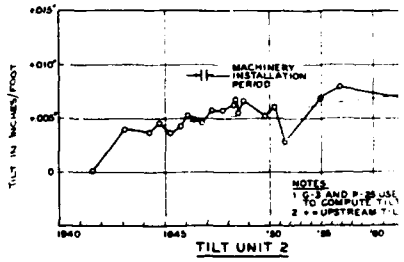
TYPICAL SECTION



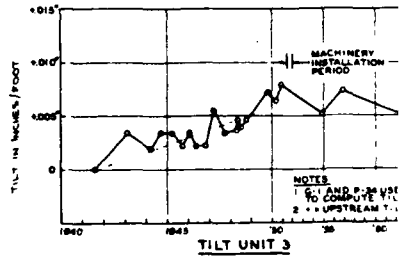
UNIT 1



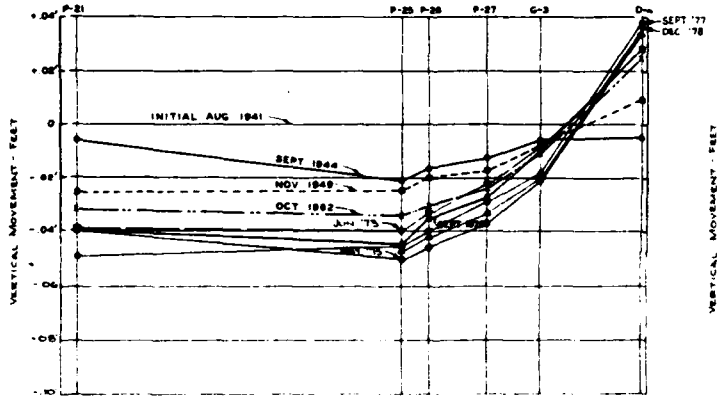
TILT UNIT 1



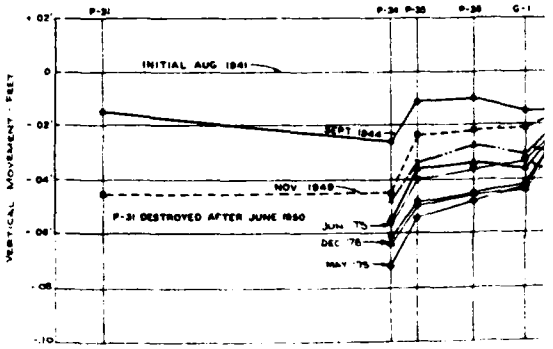
TILT UNIT 2



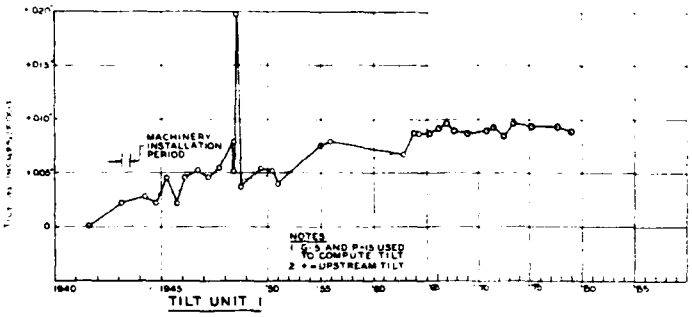
TILT UNIT 3



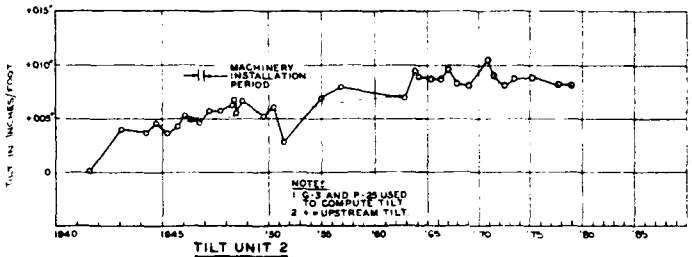
UNIT 2



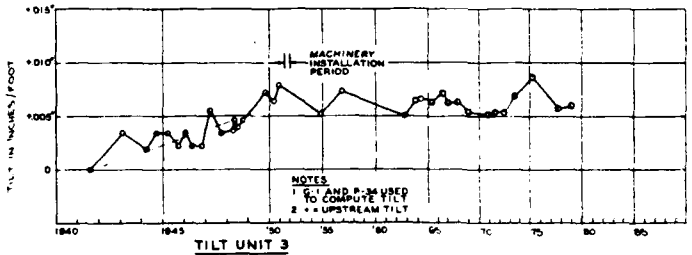
UNIT 3



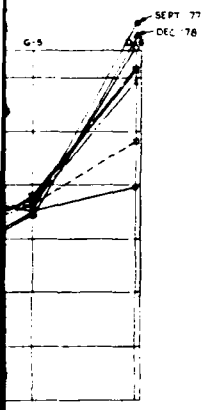
TILT UNIT 1

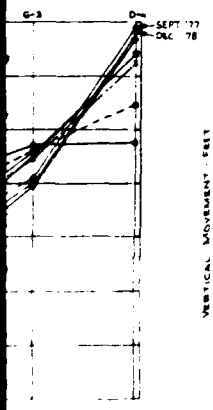


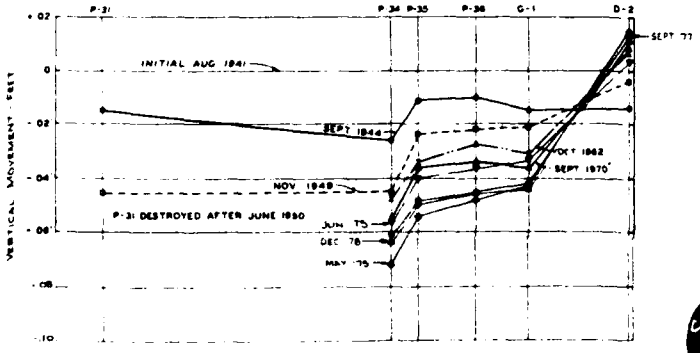
TILT UNIT 2



TILT UNIT 3







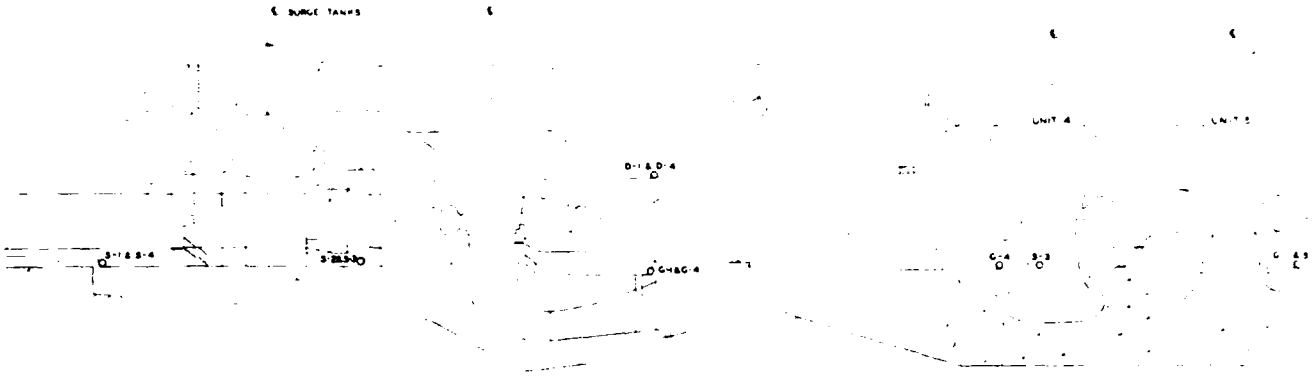
UNIT 3

THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

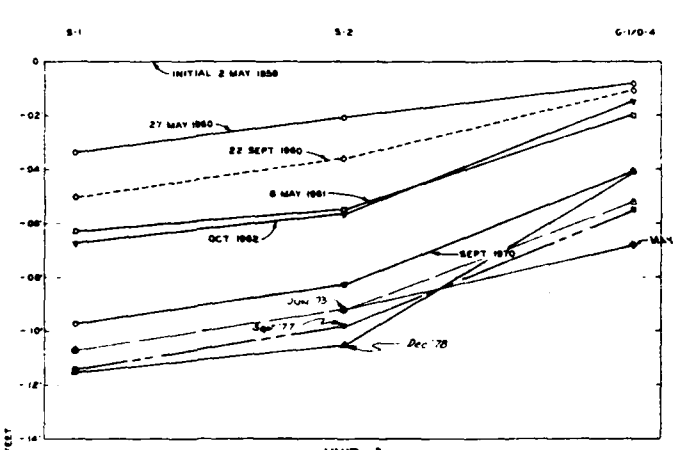
MISSOURI RIVER
FORT PECK LAKE, MONTANA
FIRST POWER PLANT
MOVEMENT OBSERVATIONS
SUMMARY OF TILT, UNITS 1, 2 & 3
SHEET 2

THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

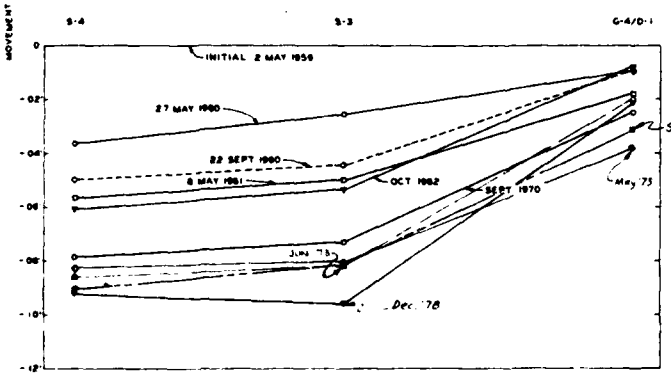


TYPICAL SECTION
UPSTREAM - DOWNSTREAM

TRANSVERSE SECTION
LOOKING UPSTREAM

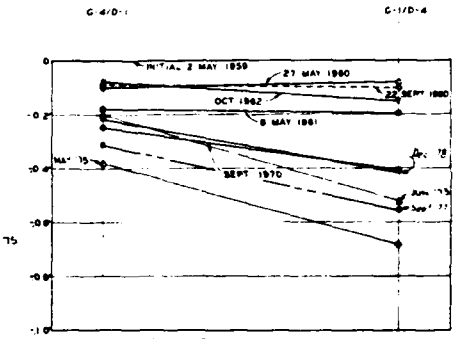


UNIT 5

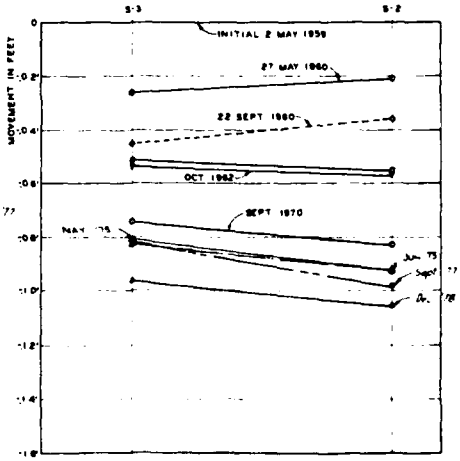


UNIT 4

UPSTREAM - DOWNSTREAM TILT OF POWERHOUSE UNITS

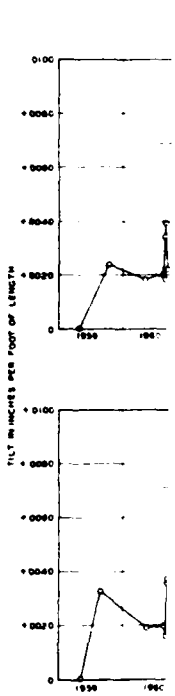


DOWNSTREAM OF UNITS

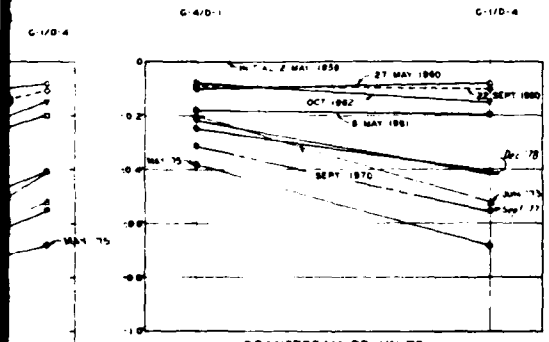


UPSTREAM OF UNITS

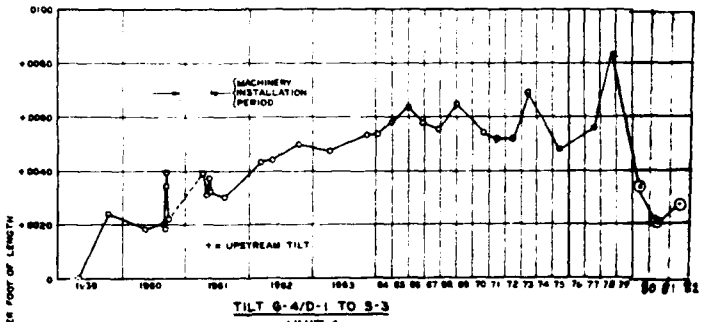
NORTH-SOUTH TILT OF POWERHOUSE UNITS



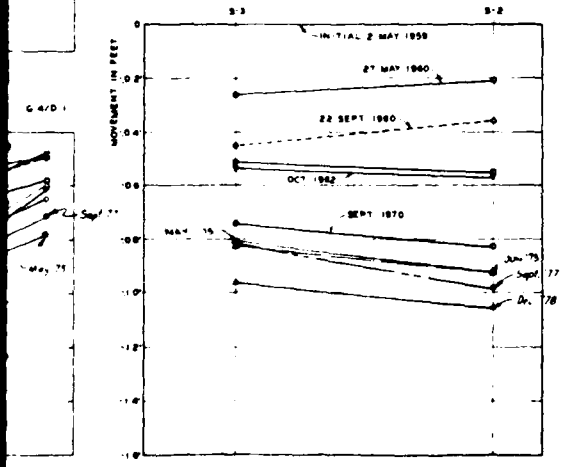
TRANSVERSE SECTION
LOOKING UPSTREAM



DOWNSTREAM OF UNITS

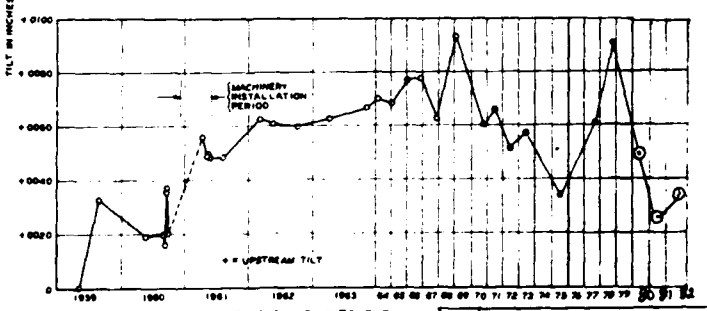


TILT G-4/D-1 TO S-3
UNIT 4



UPSTREAM OF UNITS

NORTH-SOUTH TILT OF POWERHOUSE UNITS



TILT G 1/D-4 TO S-2
UNIT 5

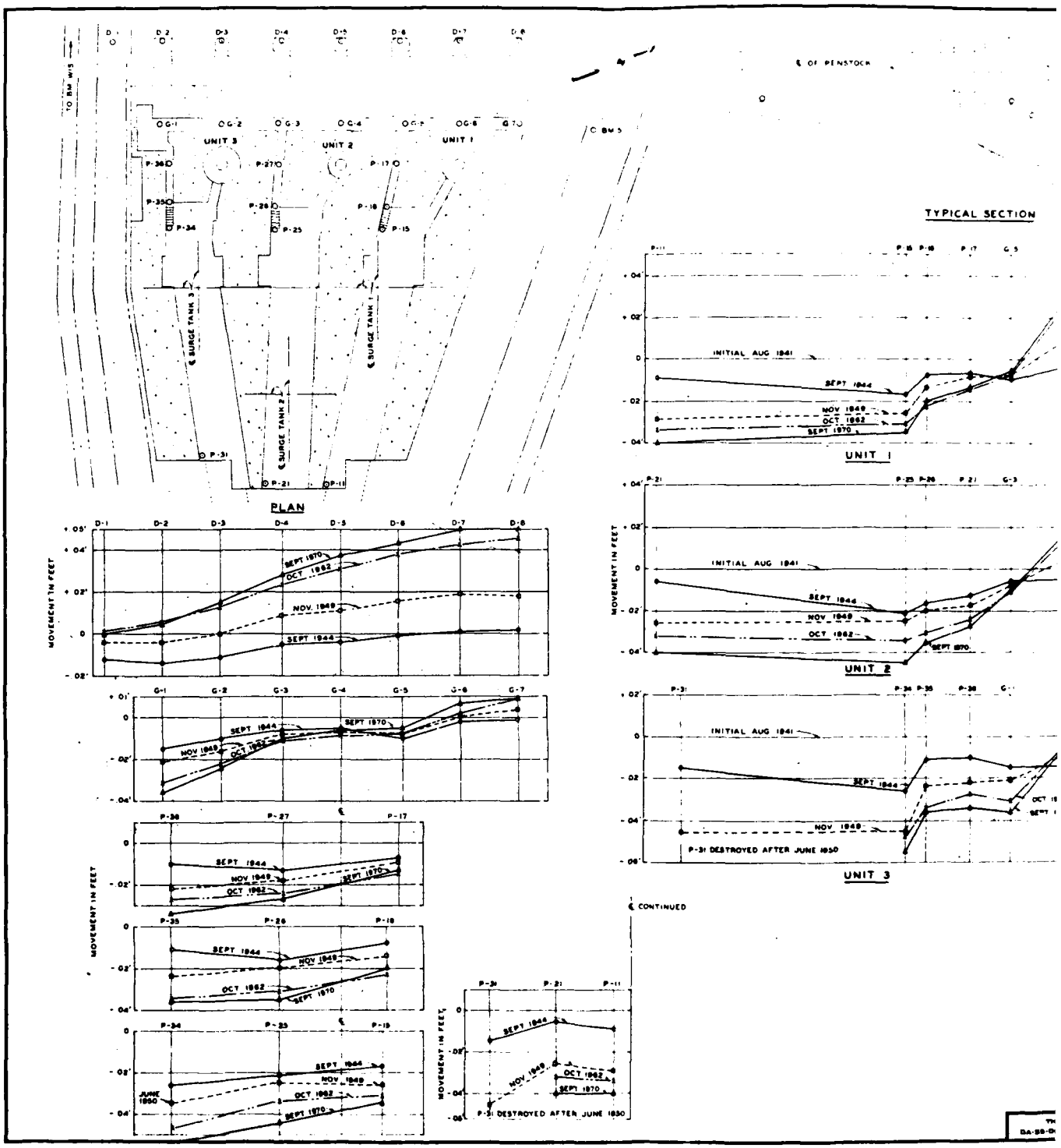
THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE

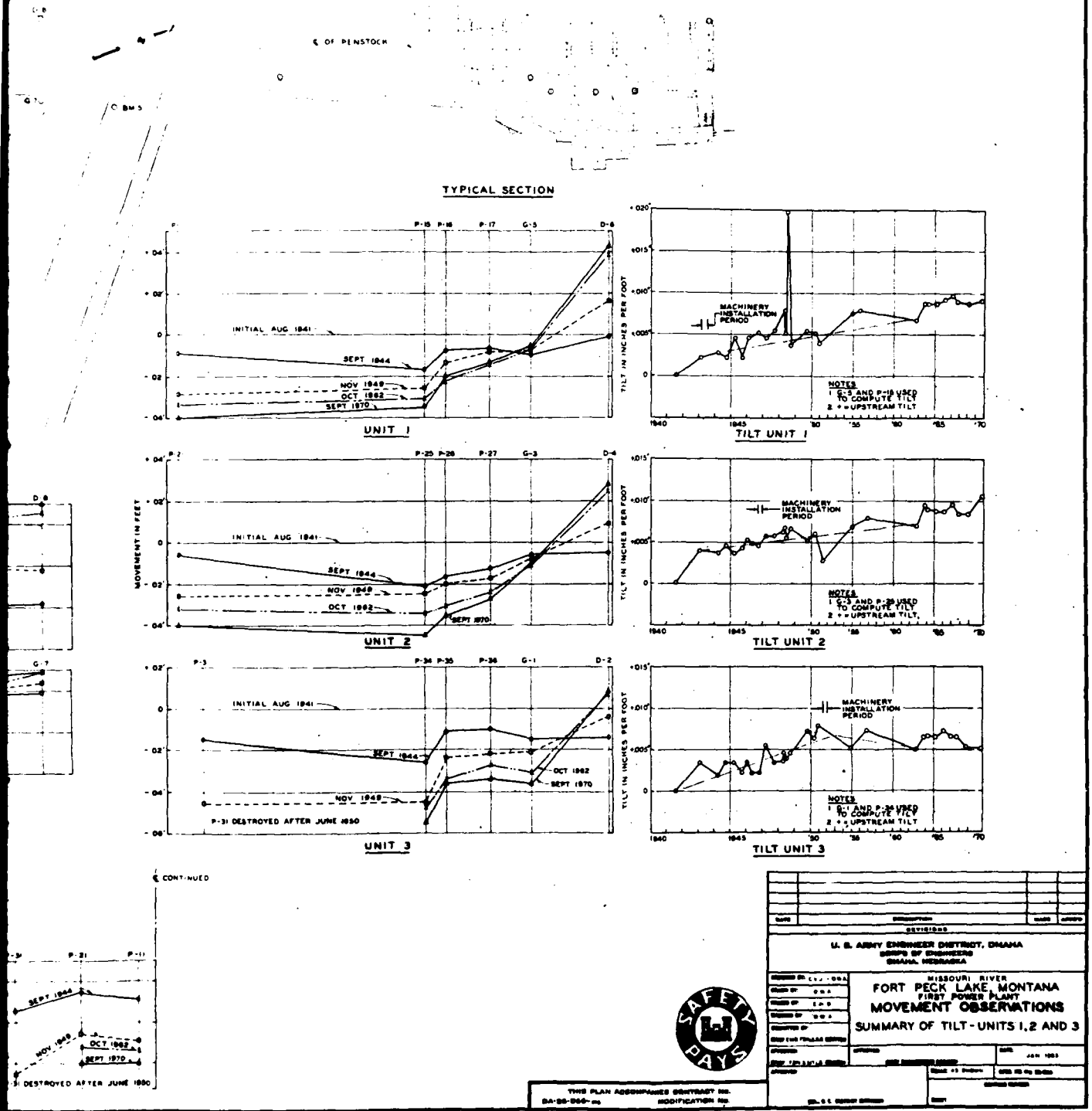
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK LAKE, MONTANA
SECOND POWER PLANT
MOVEMENT OBSERVATIONS
SUMMARY OF TILT - UNITS 4 AND 5

THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

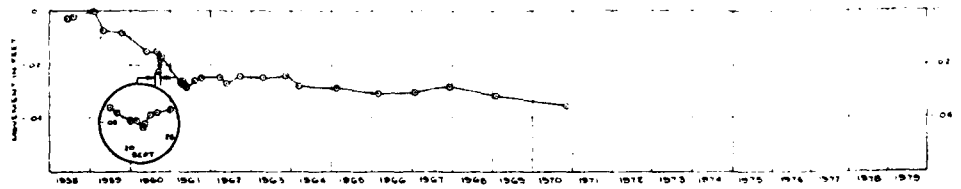
2

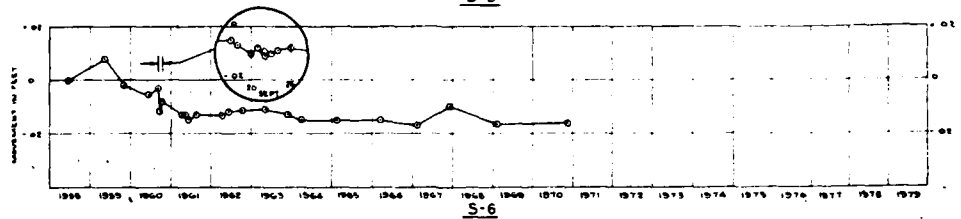

PLAN
TYPICAL SECTION
UNIT 1
UNIT 2
UNIT 3
INITIAL AUG 1941
SEPT 1944
NOV 1949
OCT 1962
SEPT 1970
JUNE 1950
P-31 DESTROYED AFTER JUNE 1950
MOVEMENT IN FEET
UNIT 3
UNIT 2
UNIT 1
℄ SURGE TANK 3
℄ SURGE TANK 2
℄ SURGE TANK 1
℄ OF PENSTOCK
TO BM W/S
BM 5
℄ CONTINUED

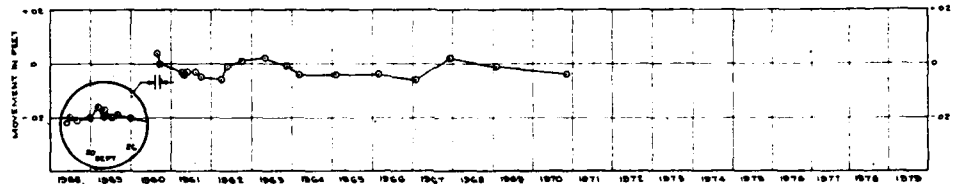


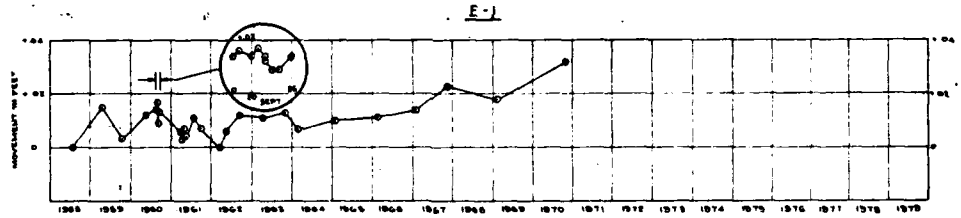
CONSTRUCTION FOUNDATION REPORT PLATE 177

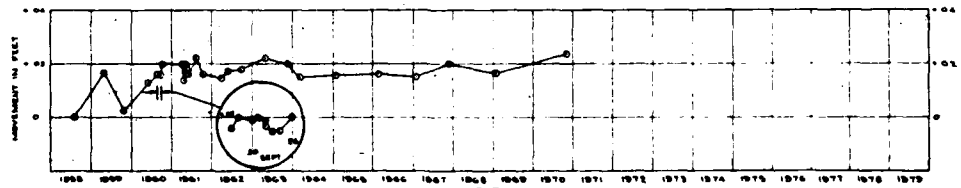
2

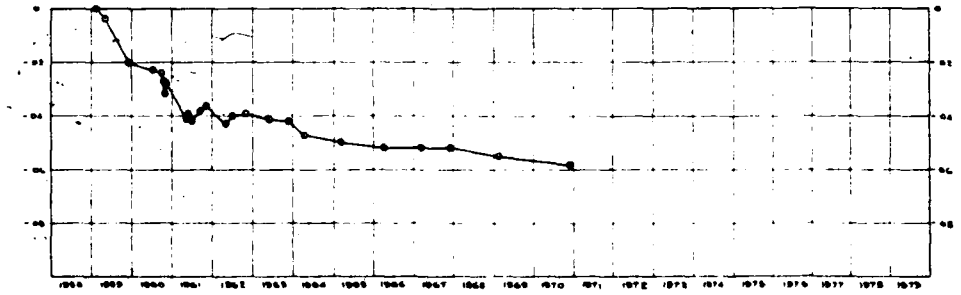




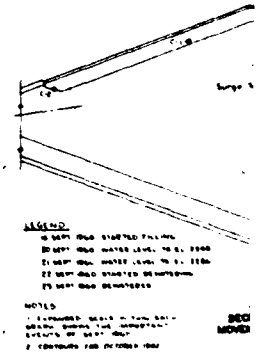


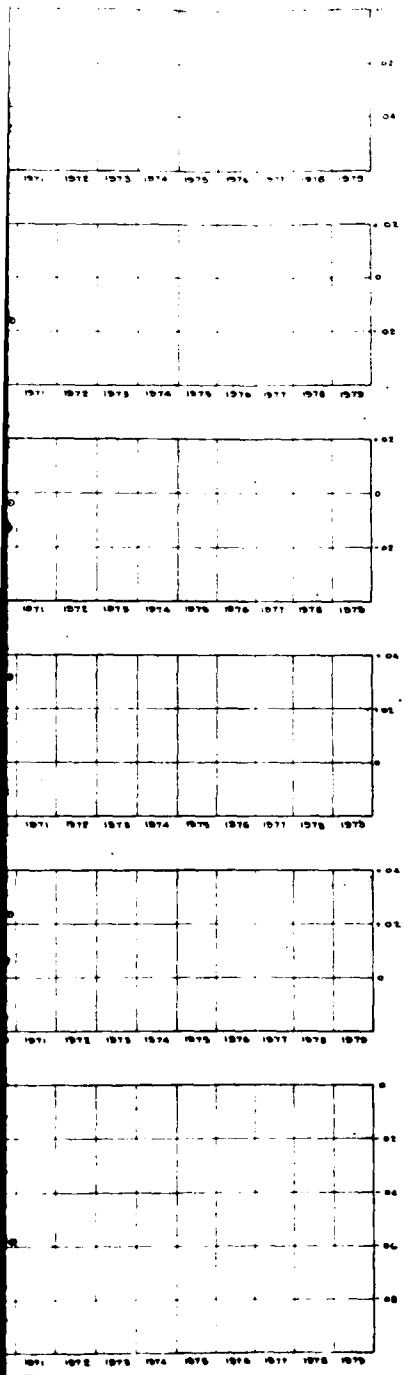


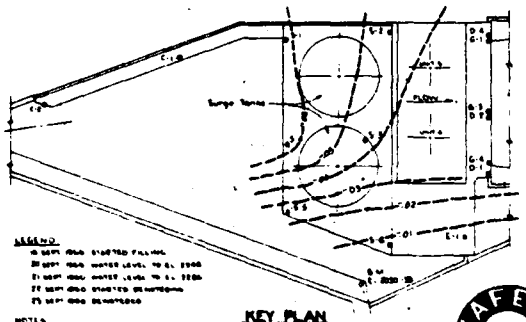




AVERAGE OF ALL MOVEMENT POINTS







KEY PLAN
SECOND POWER PLANT
MOVEMENT CONTROL POINTS

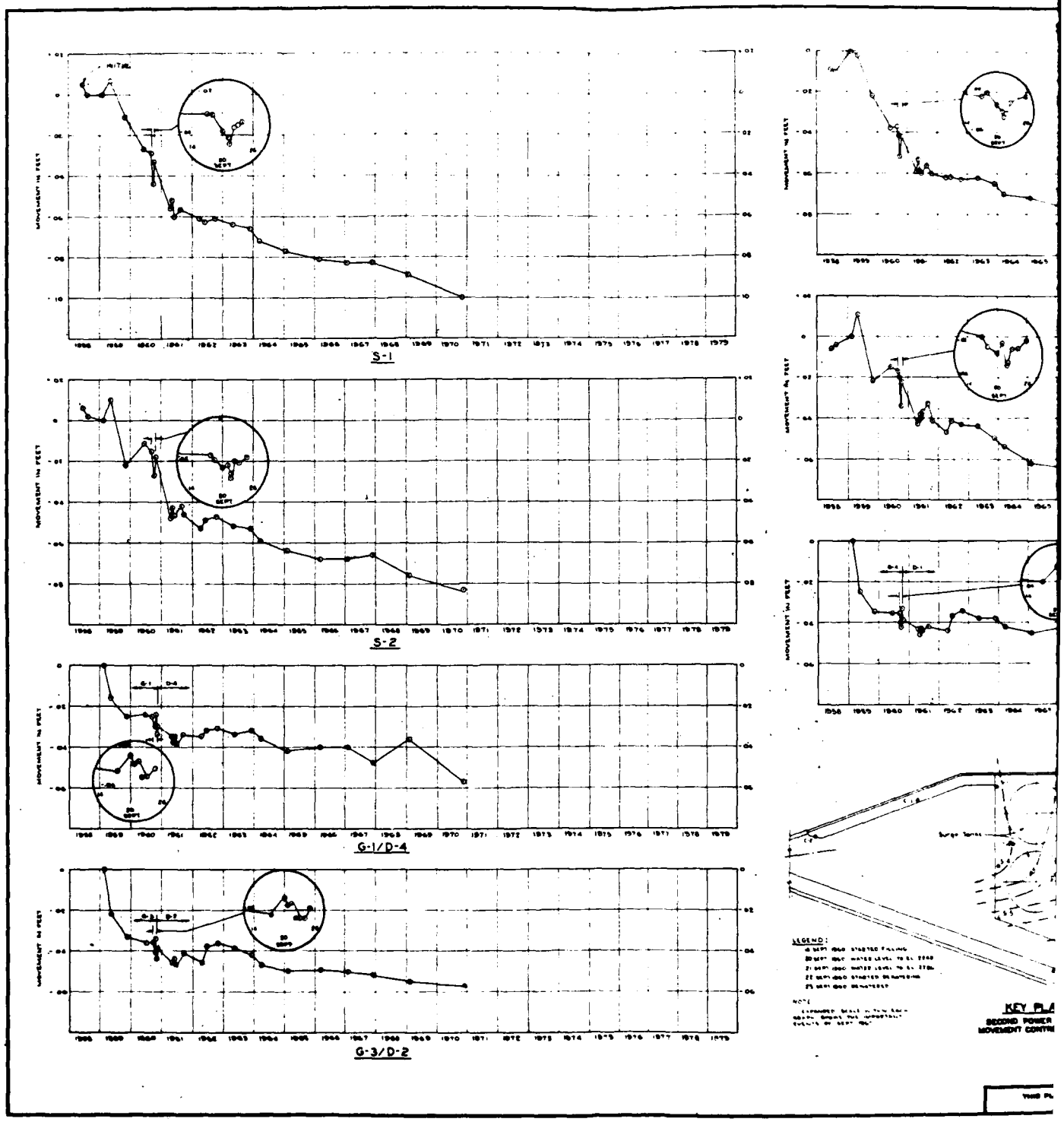
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

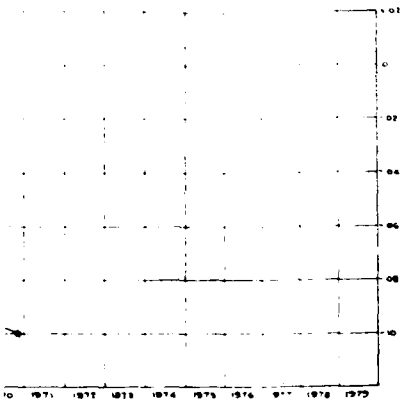
MISSOURI RIVER
FORT PECK LAKE, MONTANA
SECOND POWER PLANT

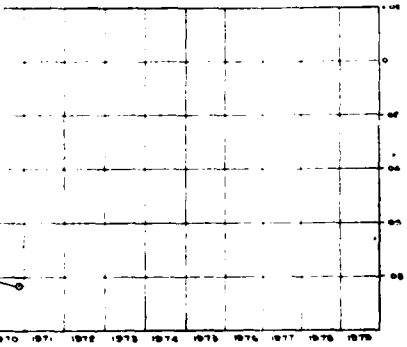
MOVEMENT OBSERVATIONS
TIME MOVEMENT RECORDS
SHEET 2 OF 2

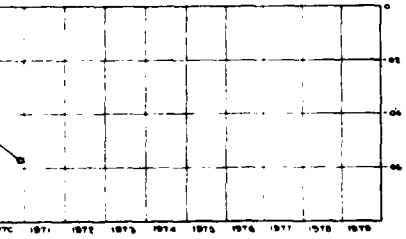
THIS PLAN ACCOMPANIES CONTRACT NO.
SUBCONTRACTOR NO.

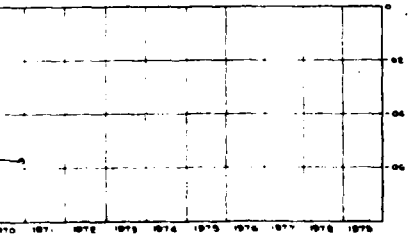
2

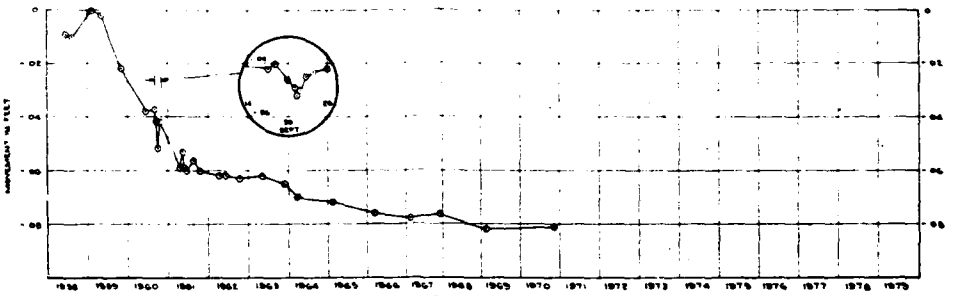

S-1
S-2
G-1/D-4
G-3/D-2
MOVEMENT IN FEET
LEGEND:
KEY PLA
SECOND POWER
MOVEMENT CONTR



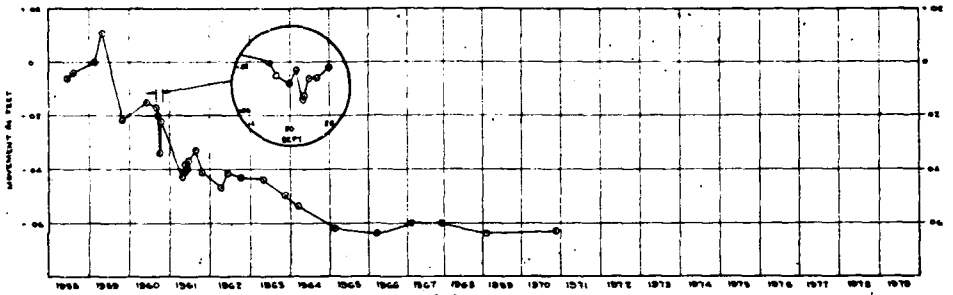




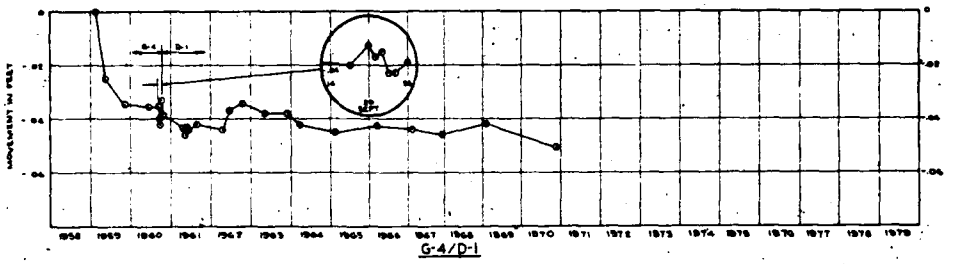




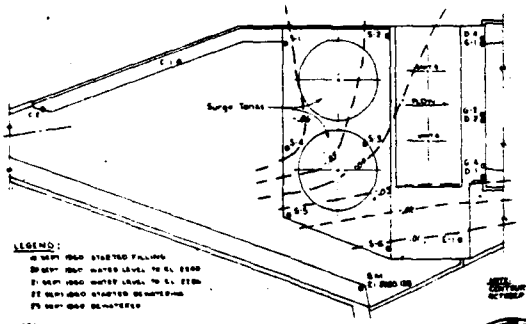
S-4



S-3



G-4/D-1



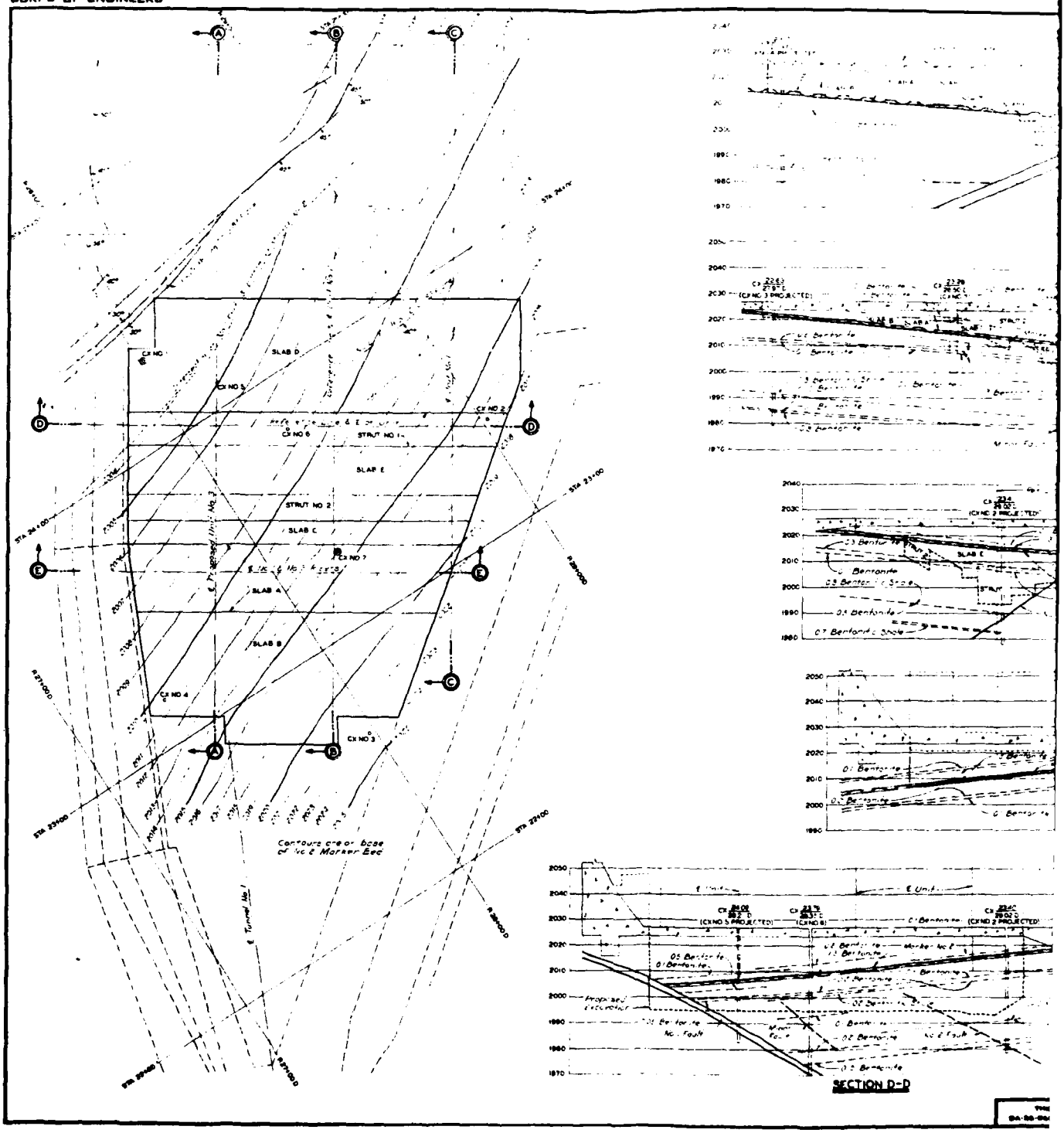
KEY PLAN
SECOND POWER PLANT
MOVEMENT CONTROL POINTS

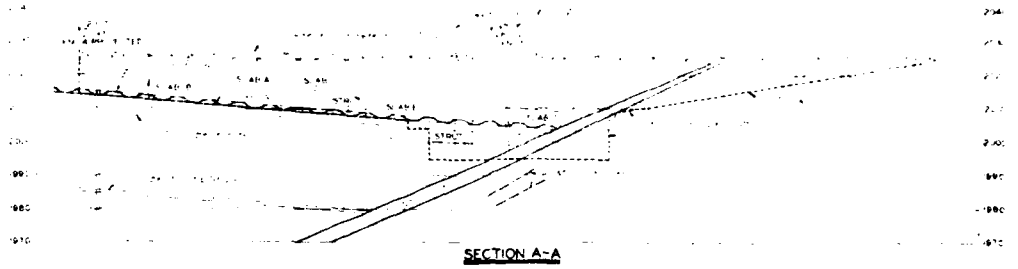
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

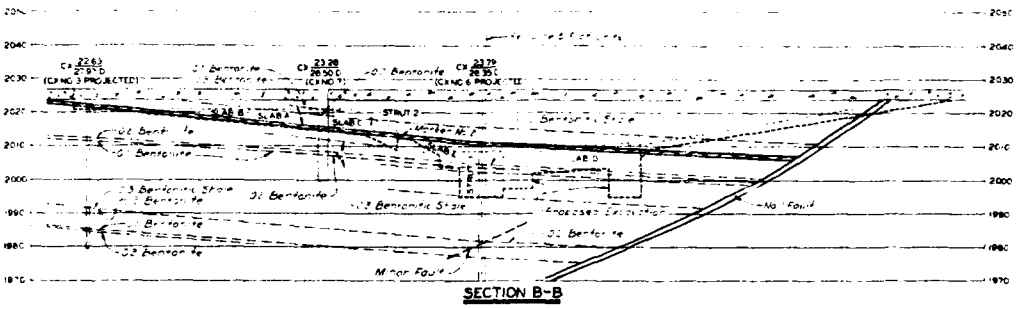
MISSOURI RIVER
FORT PECK LAKE, MONTANA
SECOND POWER PLANT
MOVEMENT OBSERVATIONS
TIME MOVEMENT RECORDS
SHEET 1 OF 2

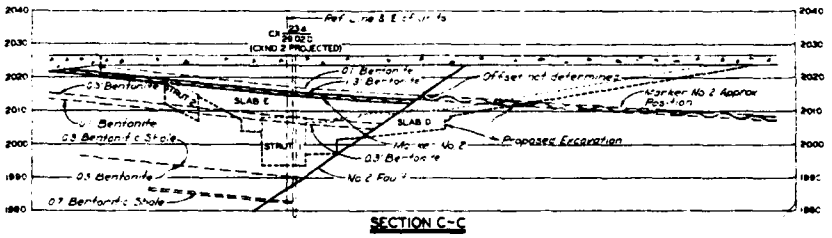
THIS PLAN ACCOMPANIES CONTRACT NO.
MODIFICATION NO.

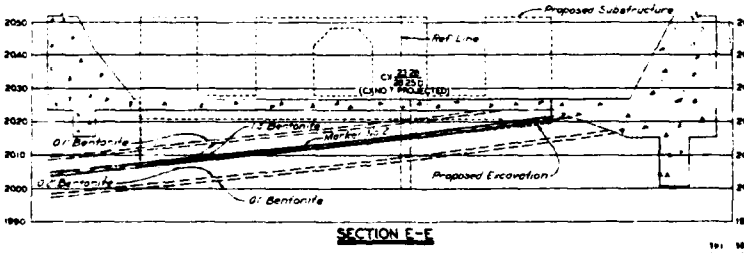
CORPS OF ENGINEERS





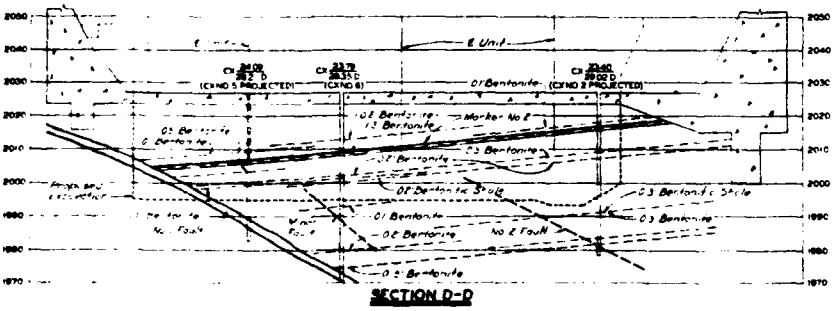






NOTE:

THIS DRAWING INCLUDES IN POWER HOUSE MOVEMENT DOCUMENTATION REPORT FOR INFORMATION ONLY.



NOTE:

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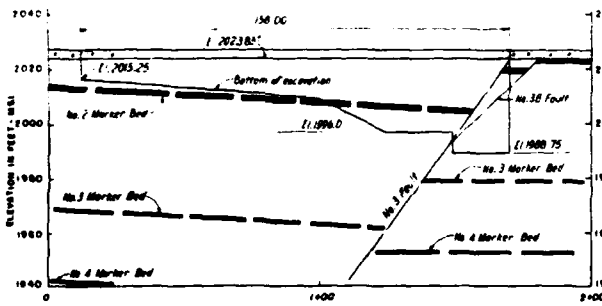
This drawing traced from only available print of 7800.1-IRS-1, dated Sept. 3, 1949.

U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

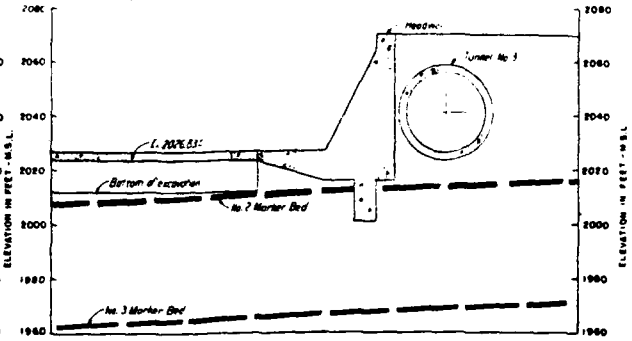
MISSOURI RIVER IMPROVEMENT
FORT PECK DAM
POWER DEVELOPMENT
POWER HOUSE
GEOLOGIC PLAN AND SECTIONS OF POWER HOUSE SITE

THIS PLAN ACCOMPANIES CONTRACT NO. DA-39-020-eng , MODIFICATION NO.

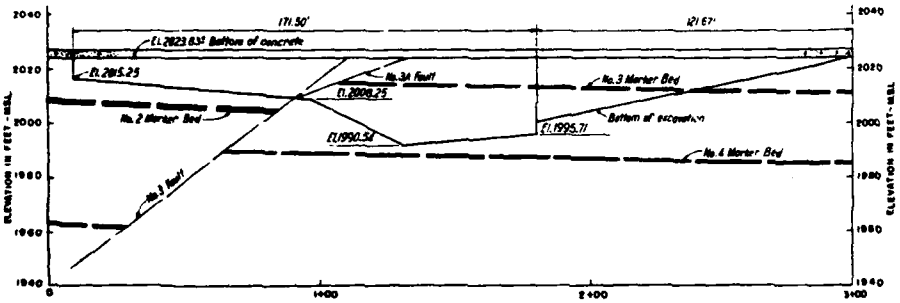
2



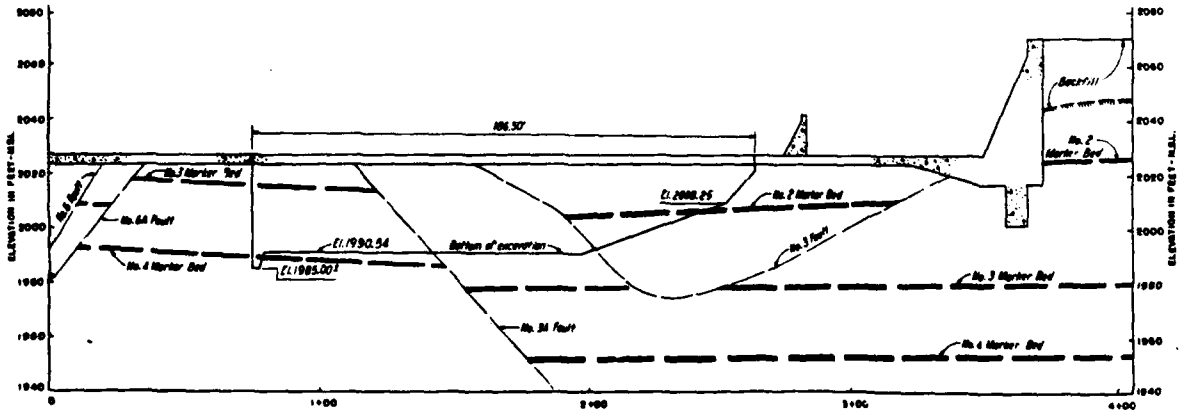
PROFILE A-A
SCALE 1" = 20'



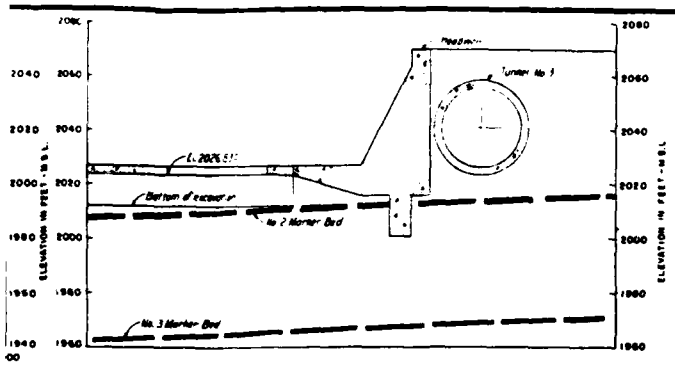
PROFILE D-D
SCALE 1" = 20'



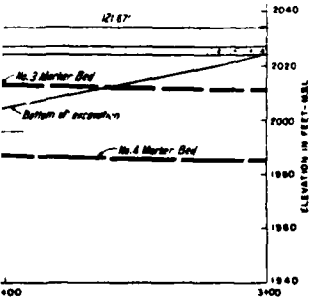
PROFILE B-B
SCALE 1" = 20'

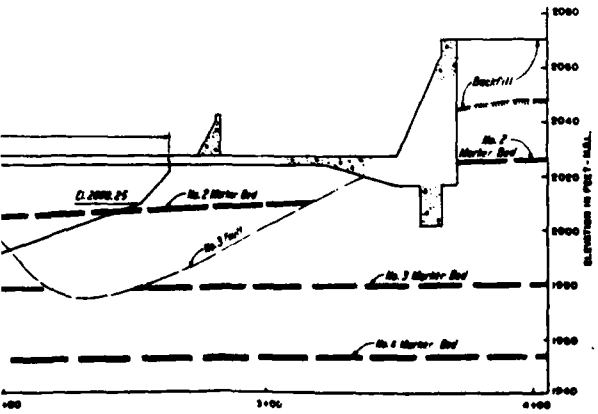


PROFILE C-C
SCALE 1" = 20'

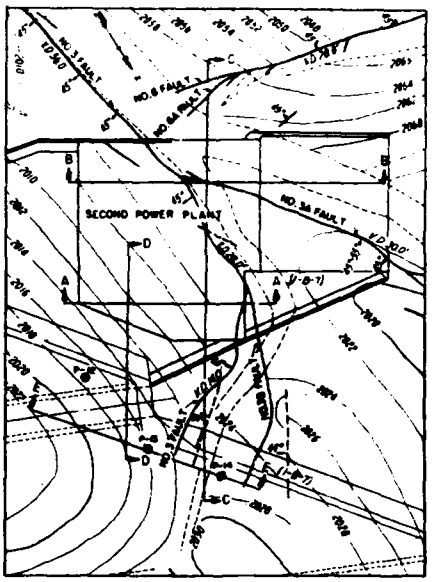


PROFILE D-D
SCALE 1"=80'





LE C-C
E 1"=80'



LOCATION PLAN
SCALE 1"=80'

NOTES:

Contours are on No. 2 Bentonite marker bed
Symbols: "Dip" = Dip of fault plane
V.D. 20.0' = Vertical displacement of fault

REFERENCE DWGS.
EXCAVATION (1-8-9)

NOTES:

- Work this drawing with 1-8-7
- Geologic interpretations shown on profiles based on adjacent borings and geologic mapping completed during initial excavations in the area.

NOTE:
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THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE.

U. S. ARMY
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
CINCINNATI, O.

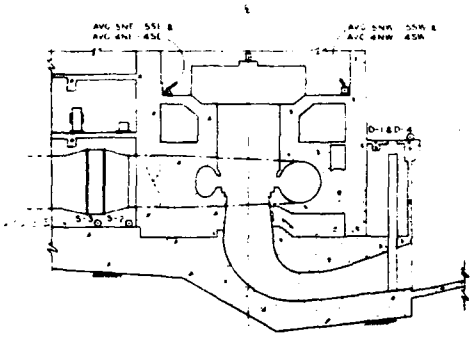
KENTUCKY RIVER DEVELOPMENT
BUCKHORN DAM-SECOND POWER PLANT
GENERAL
FOUNDATION EXPLORATIONS
SHEET 1

MAY 1956

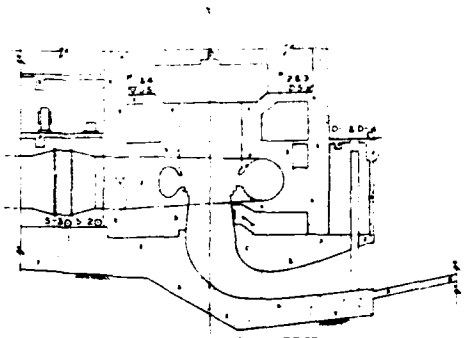
5577.1-5-6

2

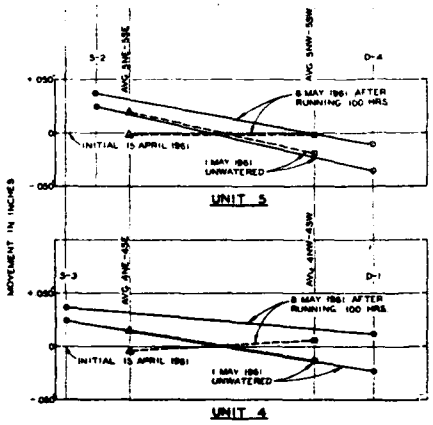
CORPS OF ENGINEERS



SURGE TANK UNWATERING TEST
TYPICAL SECTION

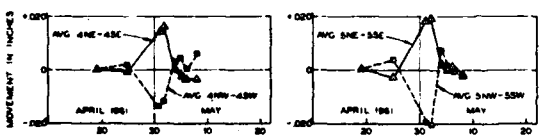


SURGE TANK LOADING TEST
TYPICAL SECTION



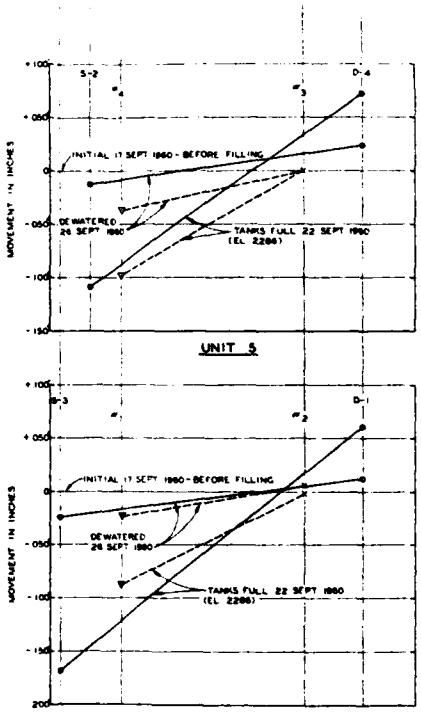
UNIT 5

UNIT 4



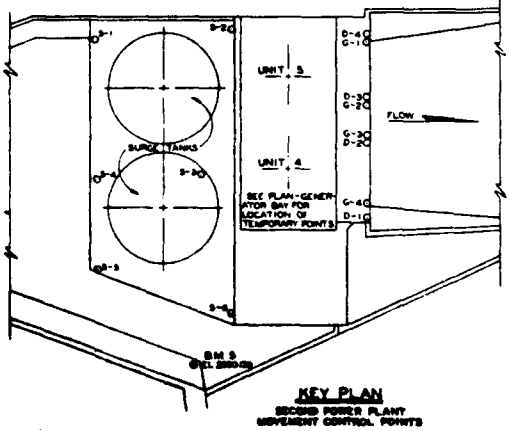
TIME MOVEMENT - UNIT 4

TIME MOVEMENT - UNIT 5



UNIT 5

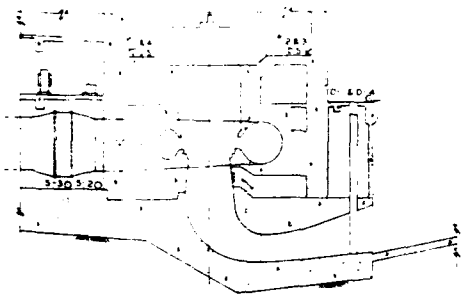
UNIT 4



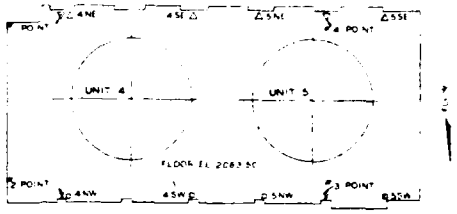
KEY PLAN
SECOND POWER PLANT
MOVEMENT CONTROL POINTS

LEGEND:

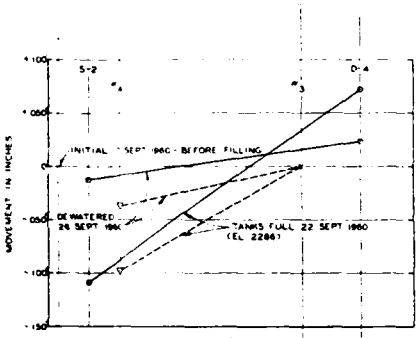
17 Sept.	1960	Before Initia
18 Sept.	1960	Dewate
20 Sept.	1960	Water
21 Sept.	1960	Water
22 Sept.	1960	Tanks
22 Sept.	1960	Water
23 Sept.	1960	Couple
24 Sept.	1960	Dewate
25 Sept.	1960	Dewate
25 Apr.	1961	Before
1 May	1961	Dewate
2 May	1961	3d hou
4 May	1961	Dewate
8 May	1961	After



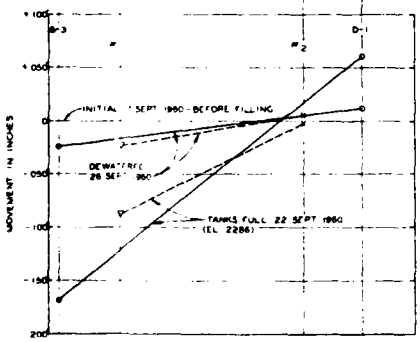
SURGE TANK LOADING TEST
TYPICAL SECTION



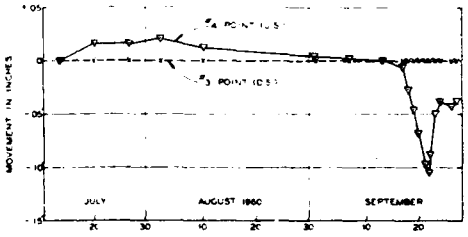
PLAN - GENERATOR BAY



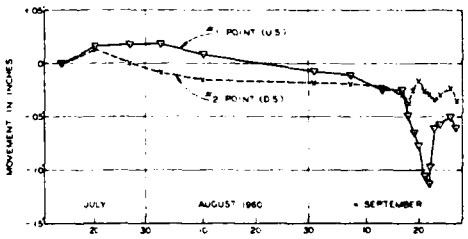
UNIT 5



UNIT 4



TIME MOVEMENT - UNIT 5



TIME MOVEMENT - UNIT 4

LEGEND:

17 Sept.	1960	Before filling Penstocks & Surge Tanks - Initial Elev. 2032.028
18 Sept.	1960	Penstocks filled to Elev. 2058
20 Sept.	1960	Water level - Elev. 2249
21 Sept.	1960	Water level - Elev. 2286
22 Sept.	1960	Tanks filled for 24 hours - 0800
22 Sept.	1960	Water level Elev. 2228 - Dewatering - 1800
23 Sept.	1960	Completely Dewatered
24 Sept.	1960	Dewatered for 36 hours
25 Sept.	1960	Dewatered for 3 days
25 Apr.	1961	Before Unwatering
1 May	1961	Penstocks & Surge Tanks Unwatered
2 May	1961	24 hours after Unwatering
4 May	1961	Penstocks & Surge Tanks Watered-up
8 May	1961	After running - Mechanical Test - 100 hours

THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE.

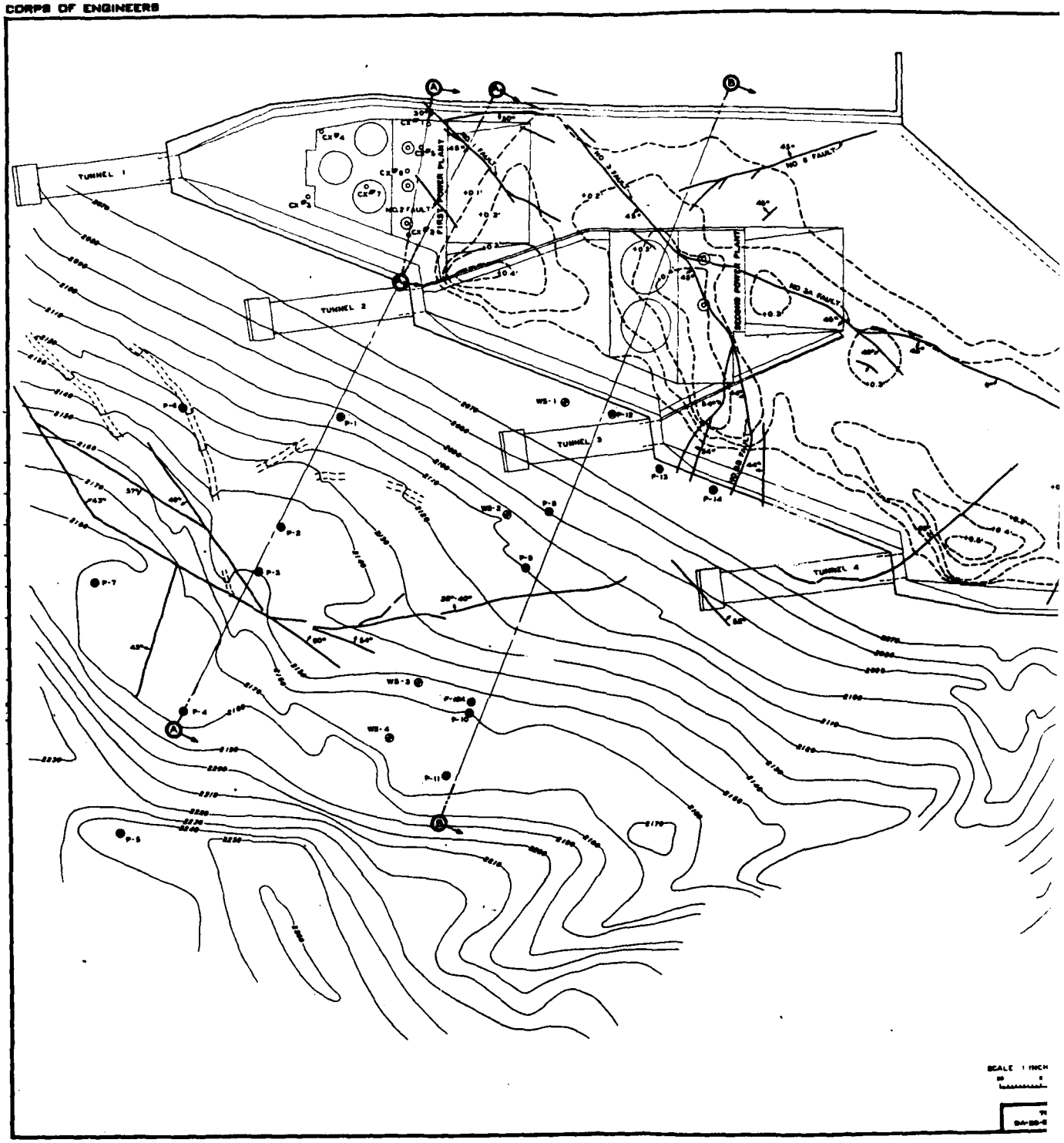
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

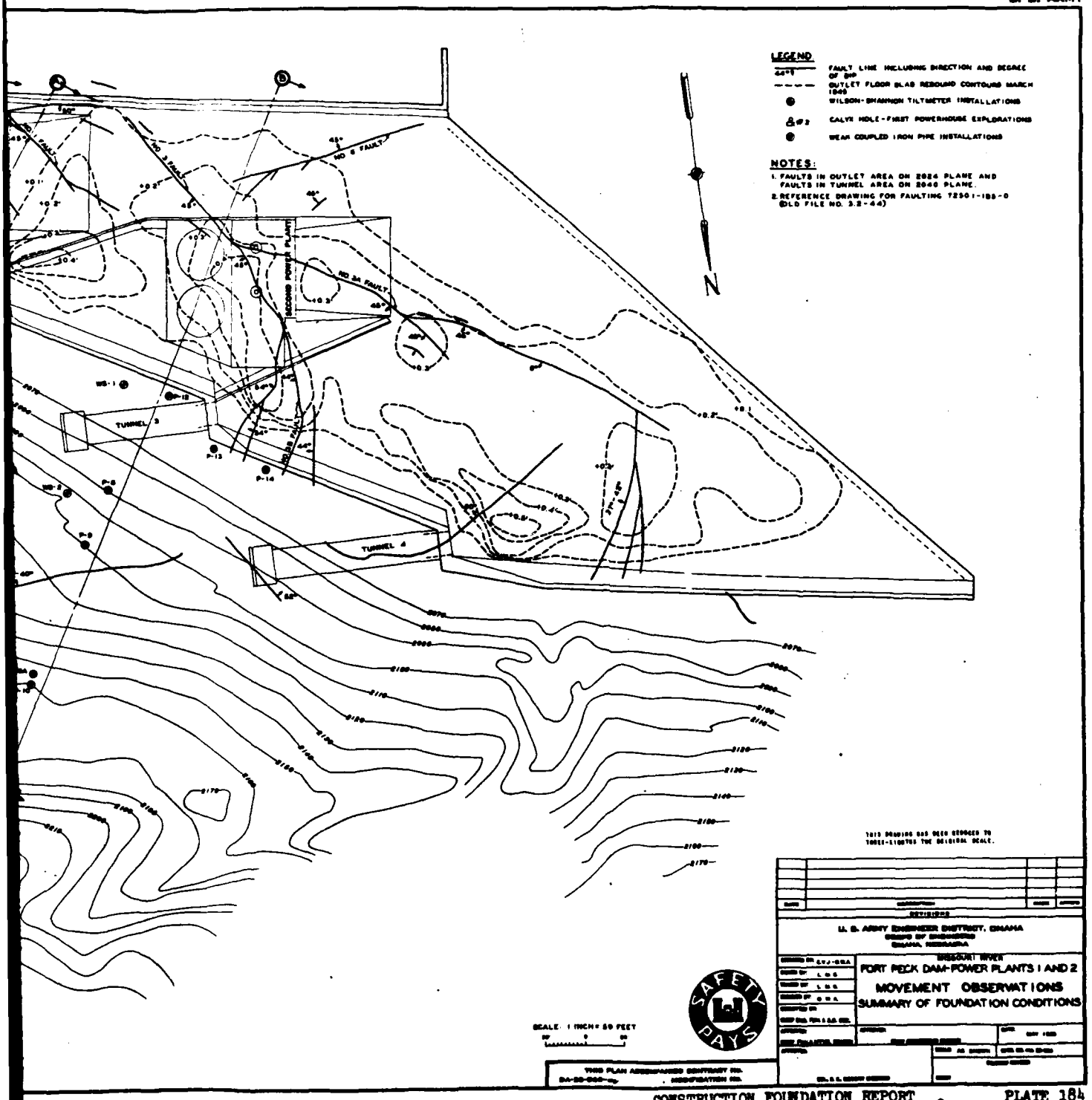
MISSOURI RIVER
FT PECK DAM - SECOND POWER PLANT
MOVEMENT OBSERVATIONS
LOADING AND UNLOADING TESTS

THIS PLAN ACCOMPANIES CONTRACT NO. DA-29-066-eng-, MODIFICATION NO.

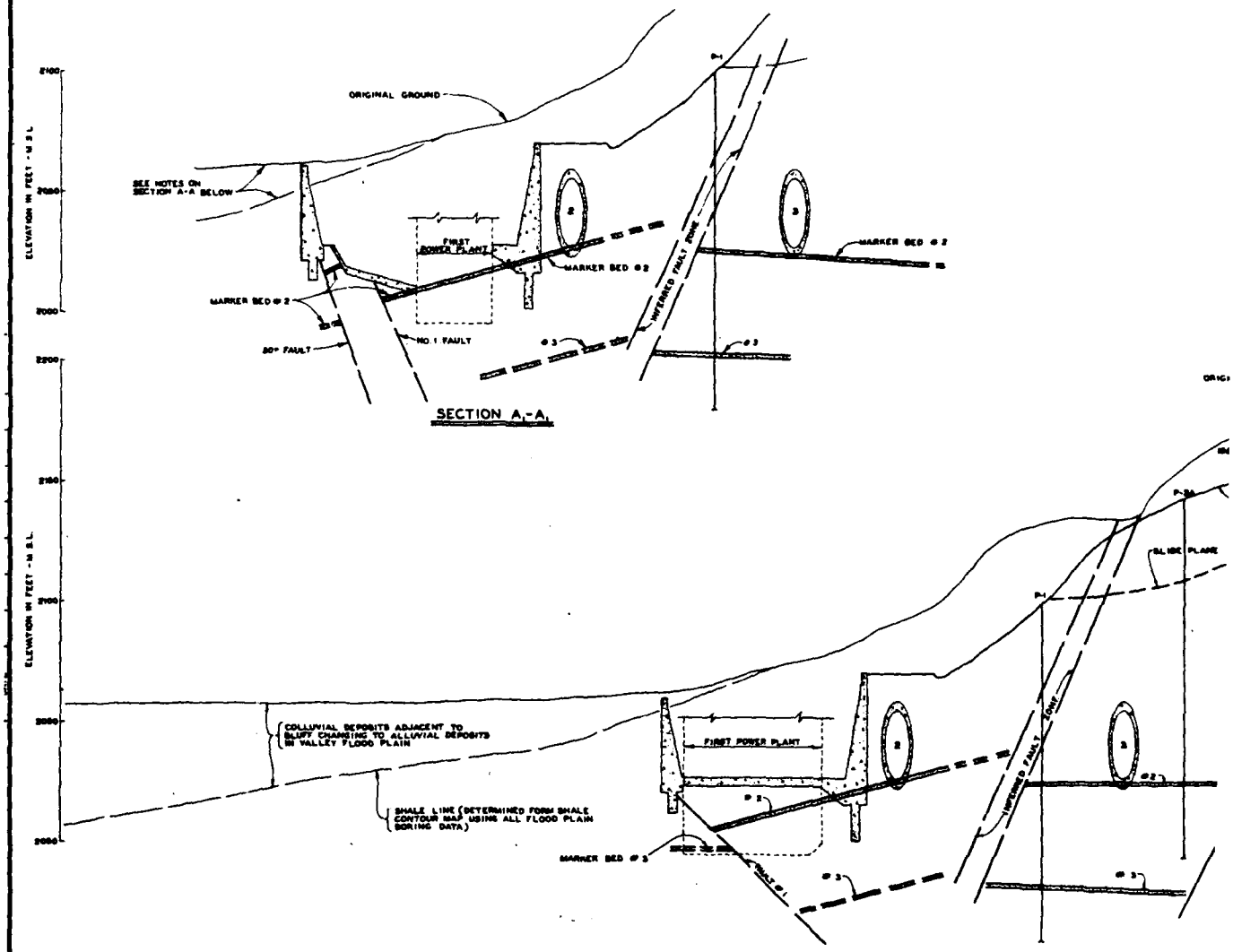
2

CORPS OF ENGINEERS



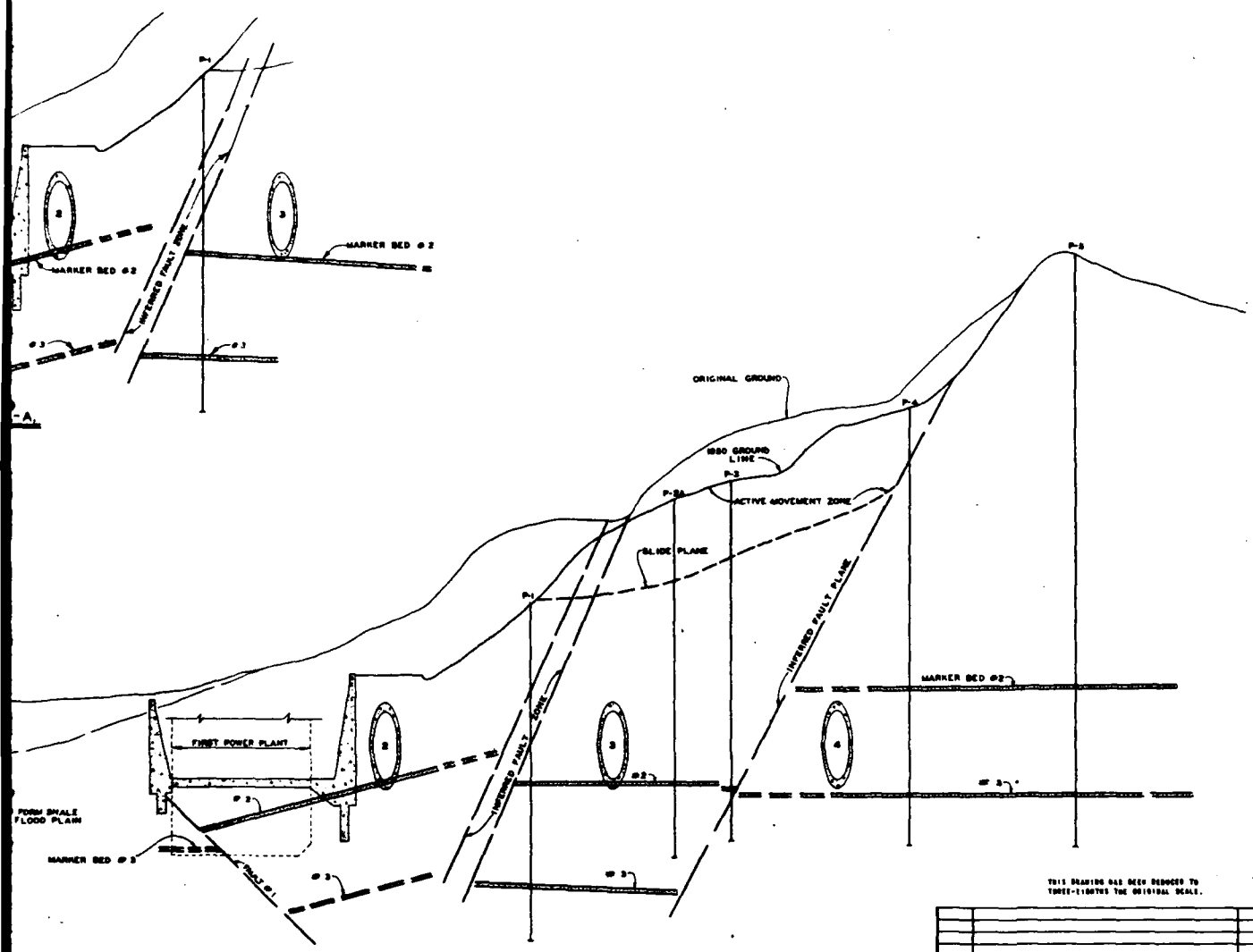

LEGEND
FAULT LINE INCLUDING DIRECTION AND DEGREE OF DIP
OUTLET FLOOR SLAB REBOUND CONTOURS MARCH 1949
WILSON-SHANNON TILTMETER INSTALLATIONS
CALYX HOLE - FIRST POWERHOUSE EXPLORATIONS
WEAK COUPLED IRON PIPE INSTALLATIONS
NOTES:
1. FAULTS IN OUTLET AREA ON 2824 PLANE AND FAULTS IN TUNNEL AREA ON 2840 PLANE.
2. REFERENCE DRAWING FOR FAULTING 72501-185-0 (OLD FILE NO. 3.2-44)
N
NO 6 FAULT
NO 3 FAULT
NO 3A FAULT
NO 3B FAULT
SECOND POWER PLANT
TUNNEL 3
TUNNEL 4
WS-1
WS-2
P-8
P-9
P-13
P-14
P-18
SCALE: 1 INCH = 50 FEET
SAFETY PAYS
U. S. ARMY ENGINEER DISTRICT, OMAHA
OMAHA, NEBRASKA
MISSOURI RIVER
FORT PECK DAM-POWER PLANTS 1 AND 2
MOVEMENT OBSERVATIONS
SUMMARY OF FOUNDATION CONDITIONS

CORPS OF ENGINEERS



NOTES:

1. ONLY MAIN BENTONITE MARKER BE[illegible] SHOWN, OTHER BENTONITE BEARS AN[illegible] GEOLOGIC DATA OMITTED
2. REFERENCE DRAWINGS - 7250 1-105 AND 7250 1-105-B



SECTION A-A

SCALE VERT. 1" = 20' HORIZ. 1" = 20'

NOTES:

1. ONLY MAIN BENTONITE MARKER BEDS SHOWN, OTHER BENTONITE SEAMS AND GEOLOGIC DATA OMITTED
2. REFERENCE DRAWINGS - 7250.1-108-3 AND 7250.1-108-6.

THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE.

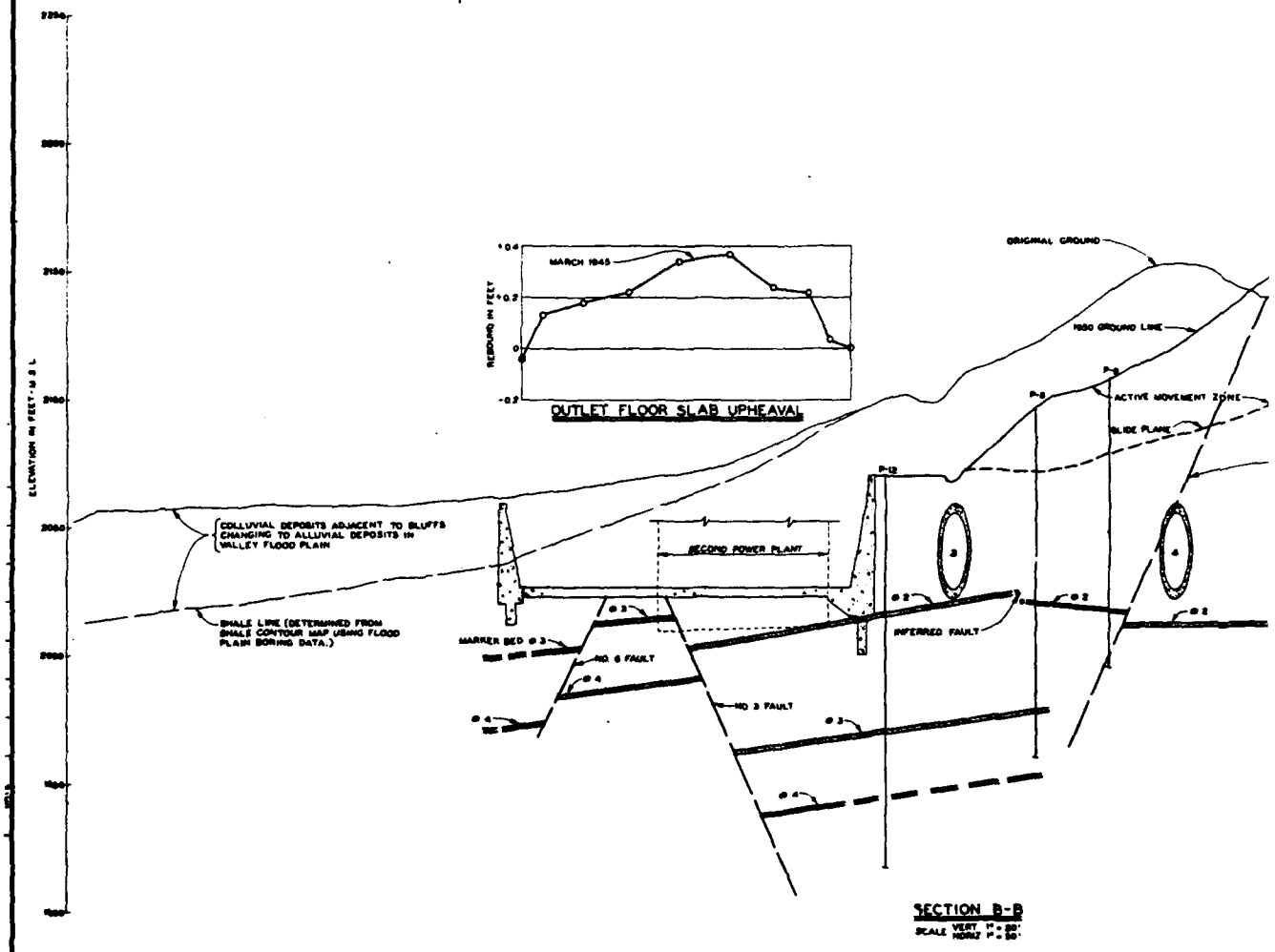
REVISIONS

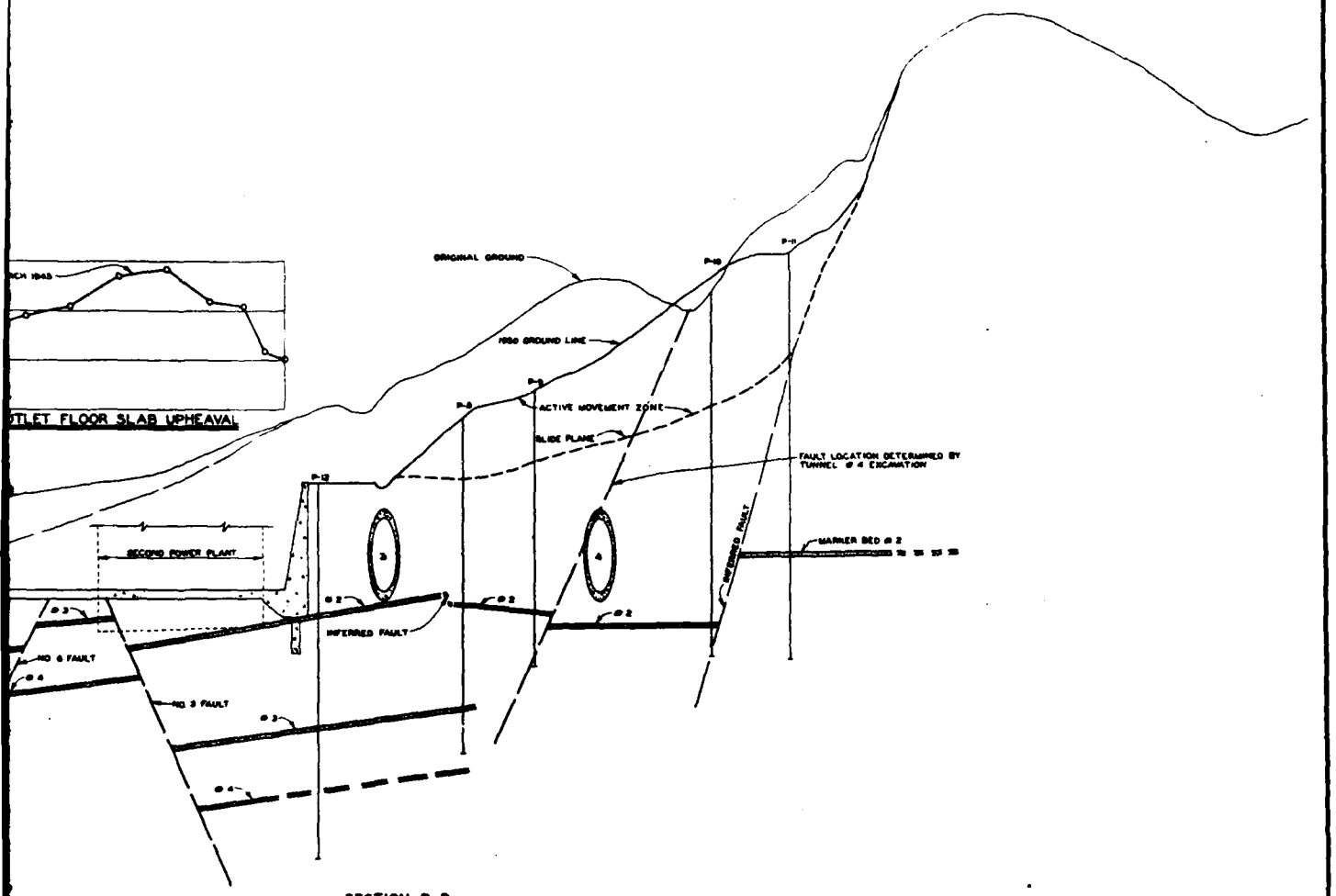
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

MISSOURI RIVER
FORT PECK DAM-FIRST POWER PLANT
MOVEMENT OBSERVATIONS
GEOLOGIC SECTIONS THROUGH
FIRST POWER PLANT

SAFETY PAYS

CORPS OF ENGINEERS





SECTION B-B

SCALE VERT. 1" = 20'
HORIZ 1" = 20'

THIS DRAWING HAS BEEN REDUCED TO THREE-EIGHTHS THE ORIGINAL SCALE.

DATE	DESCRIPTION	MADE	APPROVED

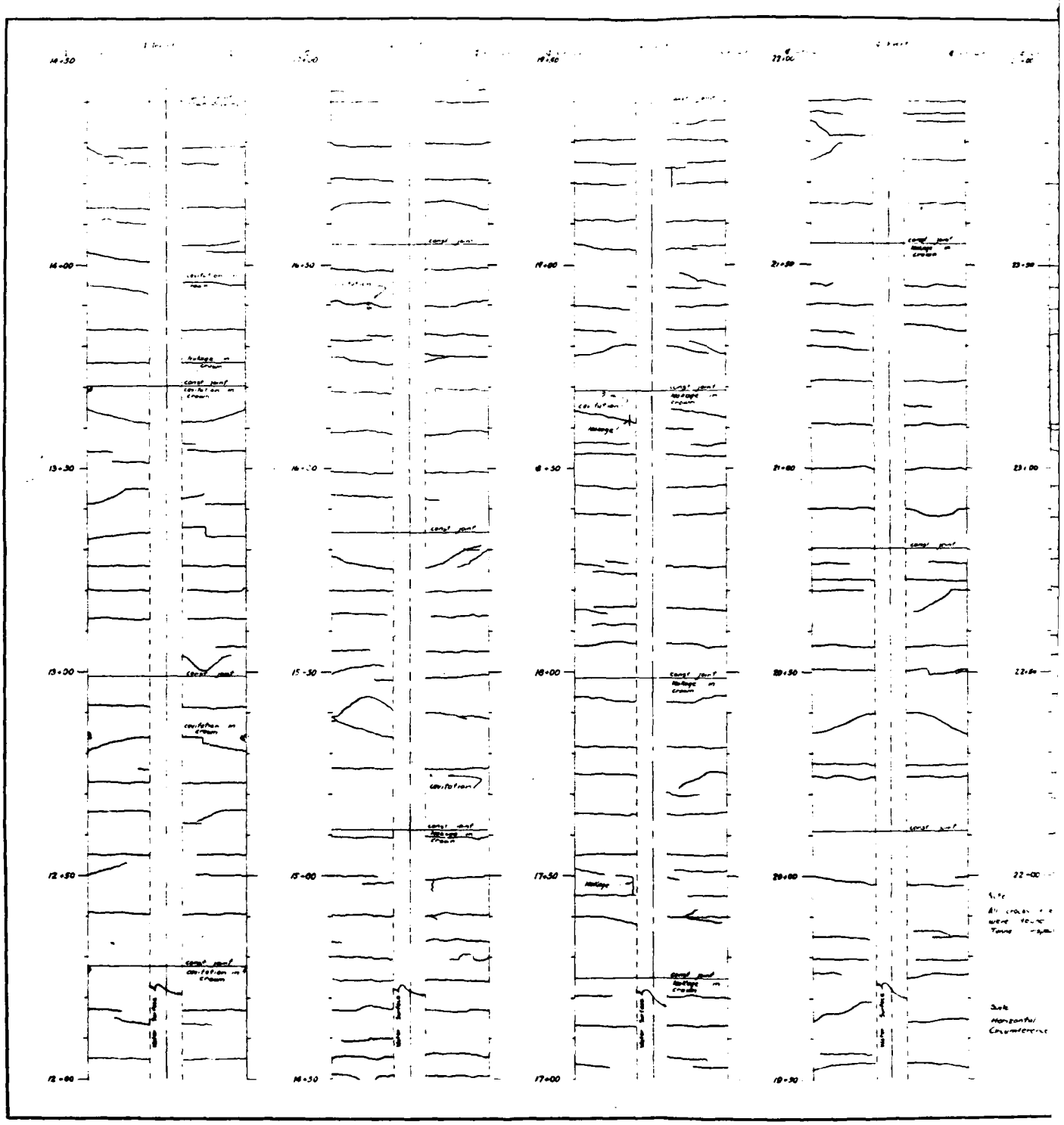
REVISIONS

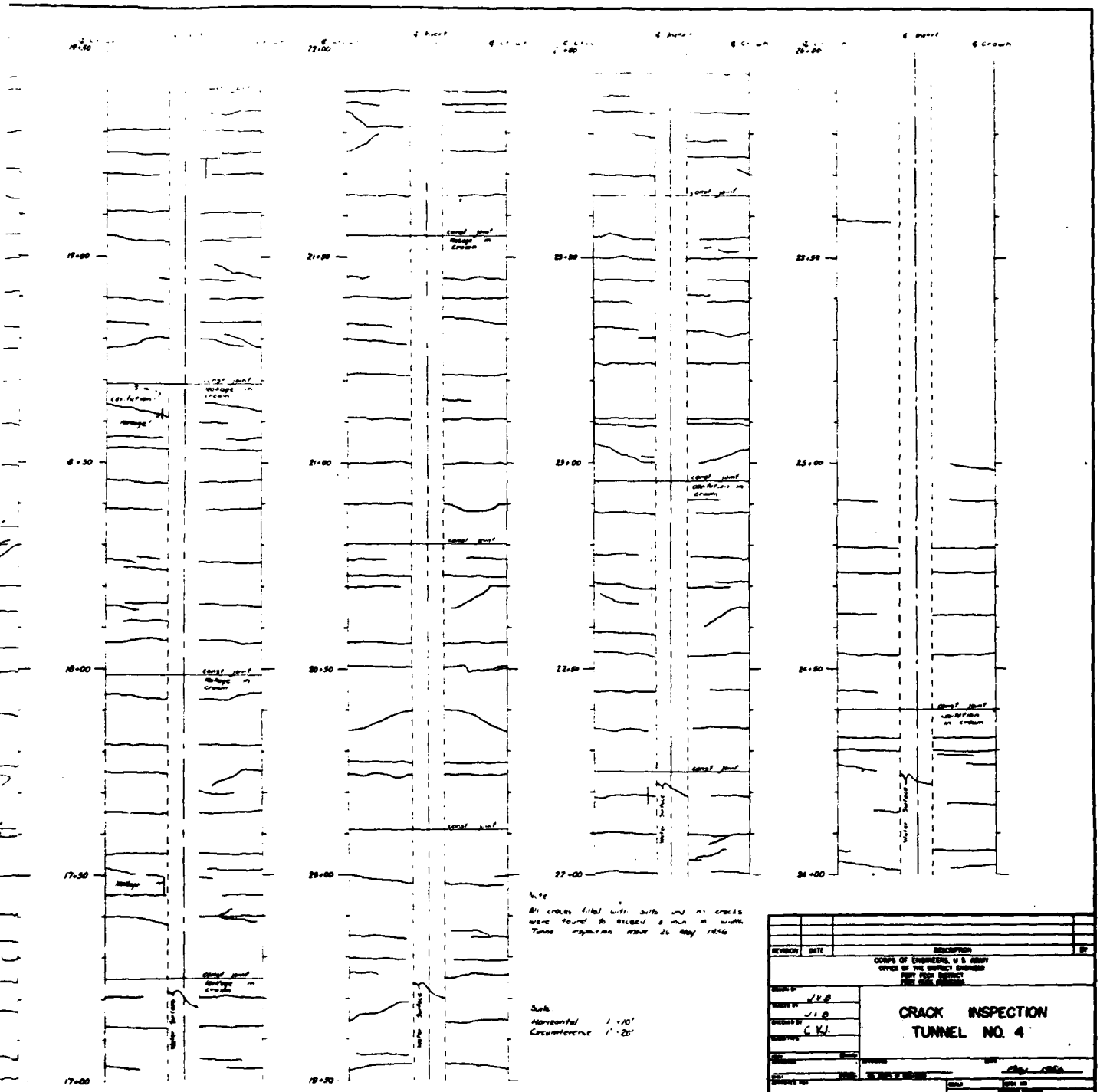
U. S. ARMY ENGINEER DISTRICT, OMAHA
CORPS OF ENGINEERS
OMAHA, NEBRASKA

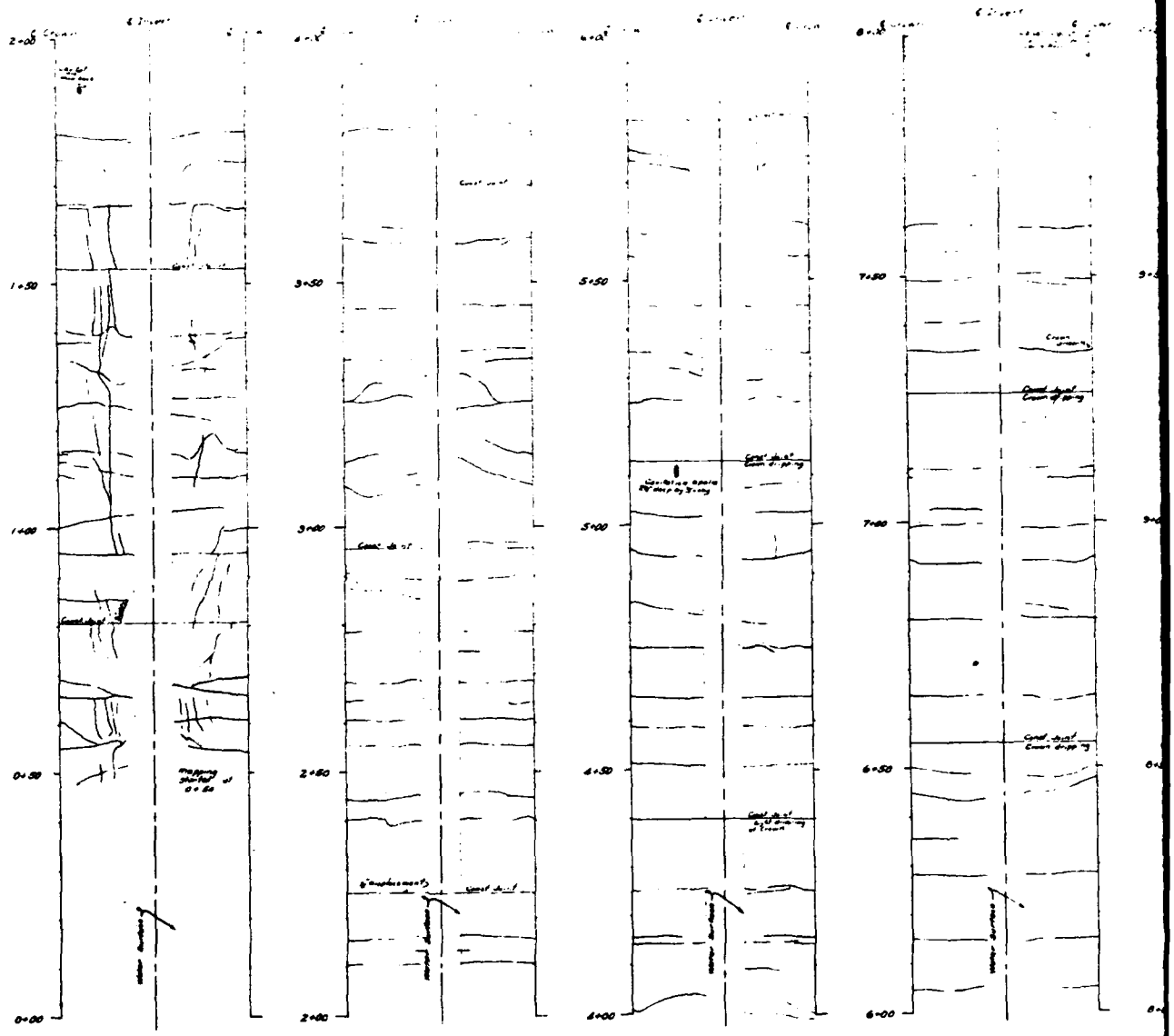
MISSOURI RIVER
FORT PECK DAM-SECOND POWER PLANT
MOVEMENT OBSERVATIONS
GEOLOGIC SECTION THROUGH SECOND POWER PLANT

SAFETY PAYS

THIS PLAN ACCOMPANIES CONTRACT NO. DA-25-066-eng-
, MODIFICATION NO.

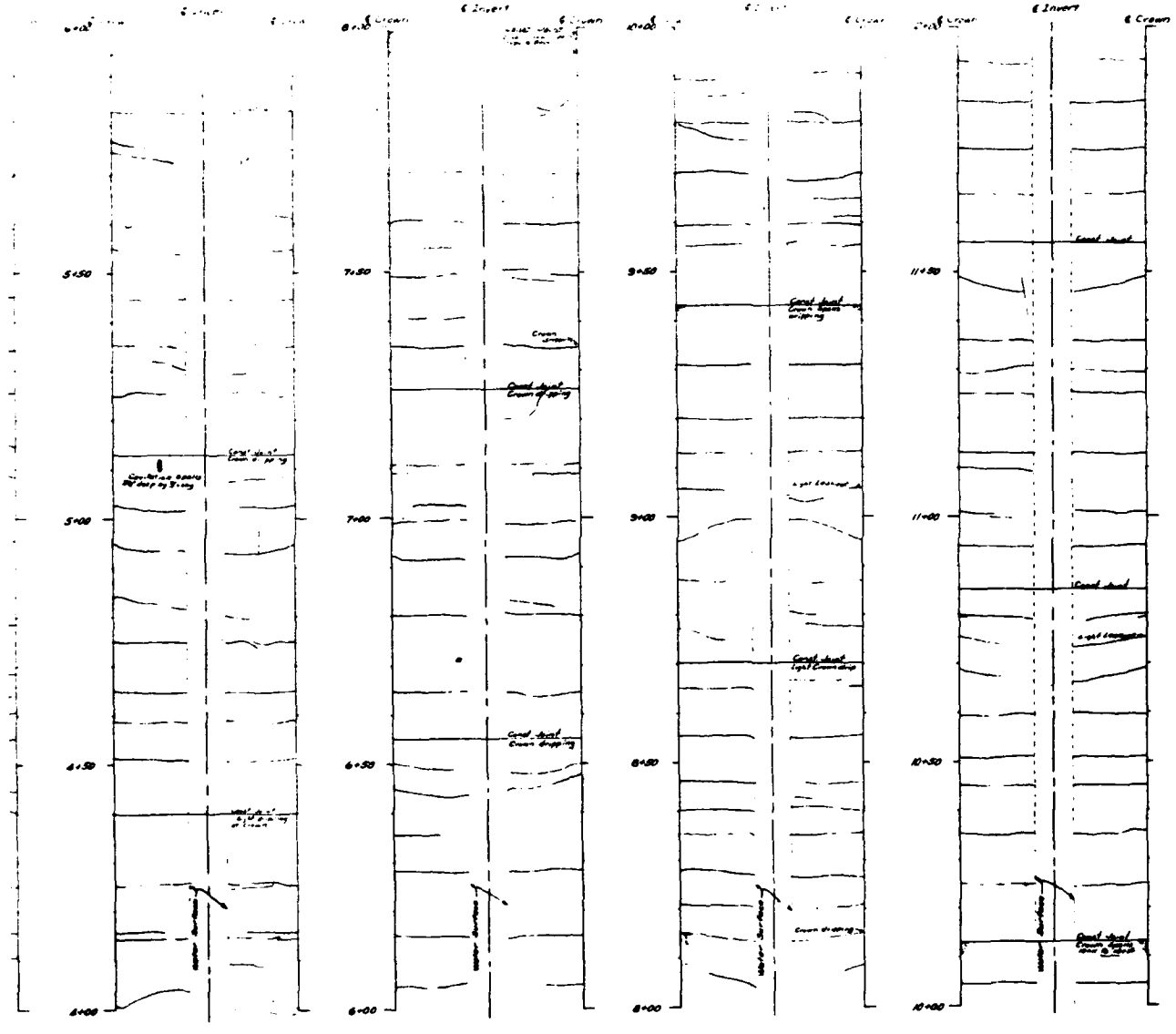

14+50
14+00
13+50
13+00
12+50
12+00
16+50
16+00
15+50
15+00
14+50
18+50
18+00
17+50
17+00
21+00
20+50
20+00
19+50
23+00
22+50
22+00
const joint
cavitation
leakage
Note
Horizontal
Circumferential


19+50
22+00
23+00
24+00
19+00
21+50
23+50
25+50
18+50
21+00
23+00
25+00
18+00
20+50
22+50
24+50
17+50
20+00
22+00
24+00
17+00
19+50
℄ Crown
Const joint
Water Surface
Note
All cracks filled with salts and no cracks were found to exceed 0 mm in width. Tunnel inspection made 26 May 1956
Scale
Horizontal 1"=10'
Circumference 1"=20'
REVISION
DATE
DESCRIPTION
BY
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
FORT PECK DISTRICT
FORT PECK, MONTANA
DRAWN BY J.V.B.
TRACED BY J.V.B.
CHECKED BY C.K.J.
CRACK INSPECTION
TUNNEL NO. 4
64651-1-106
SHEET 2 of 2

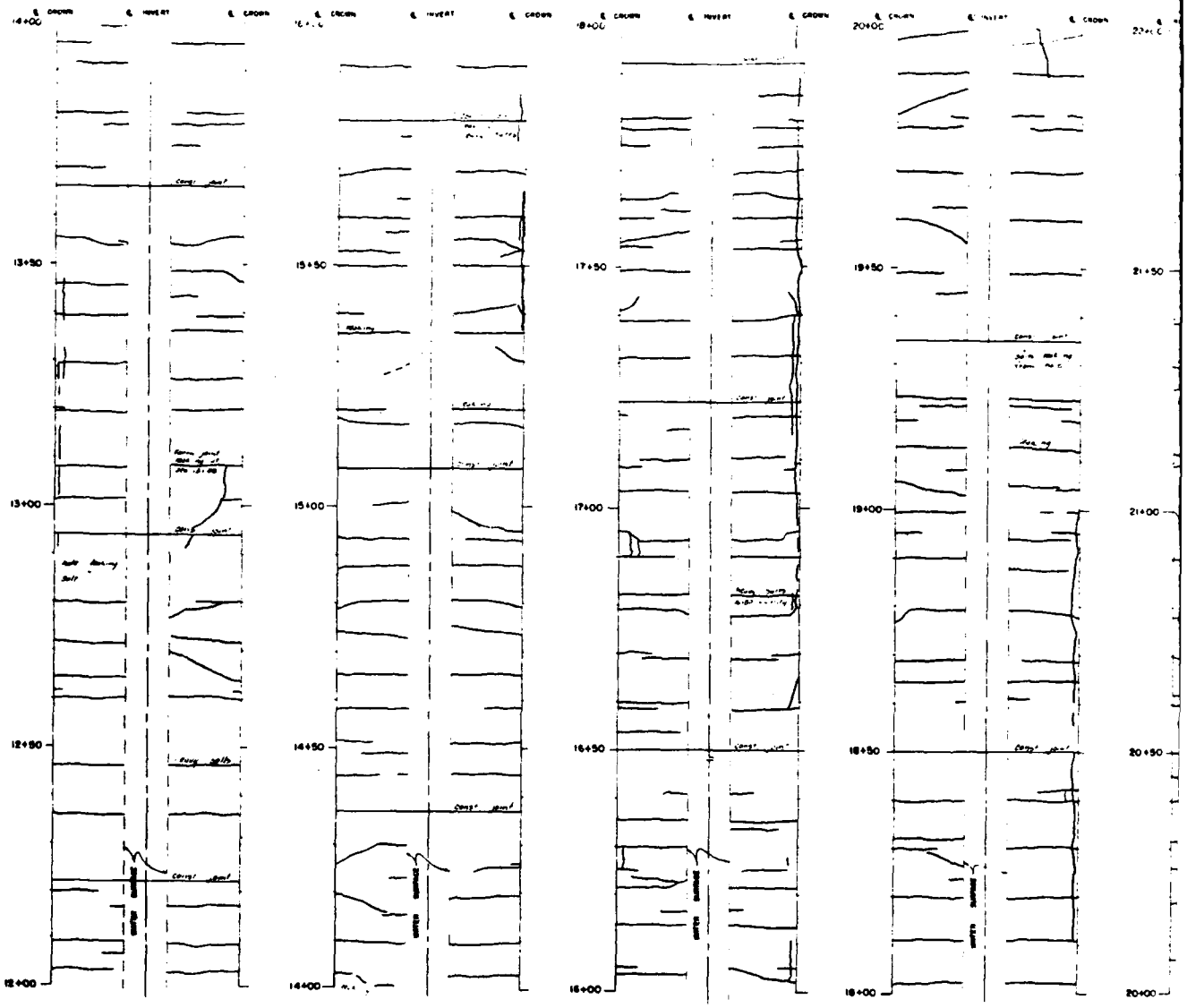


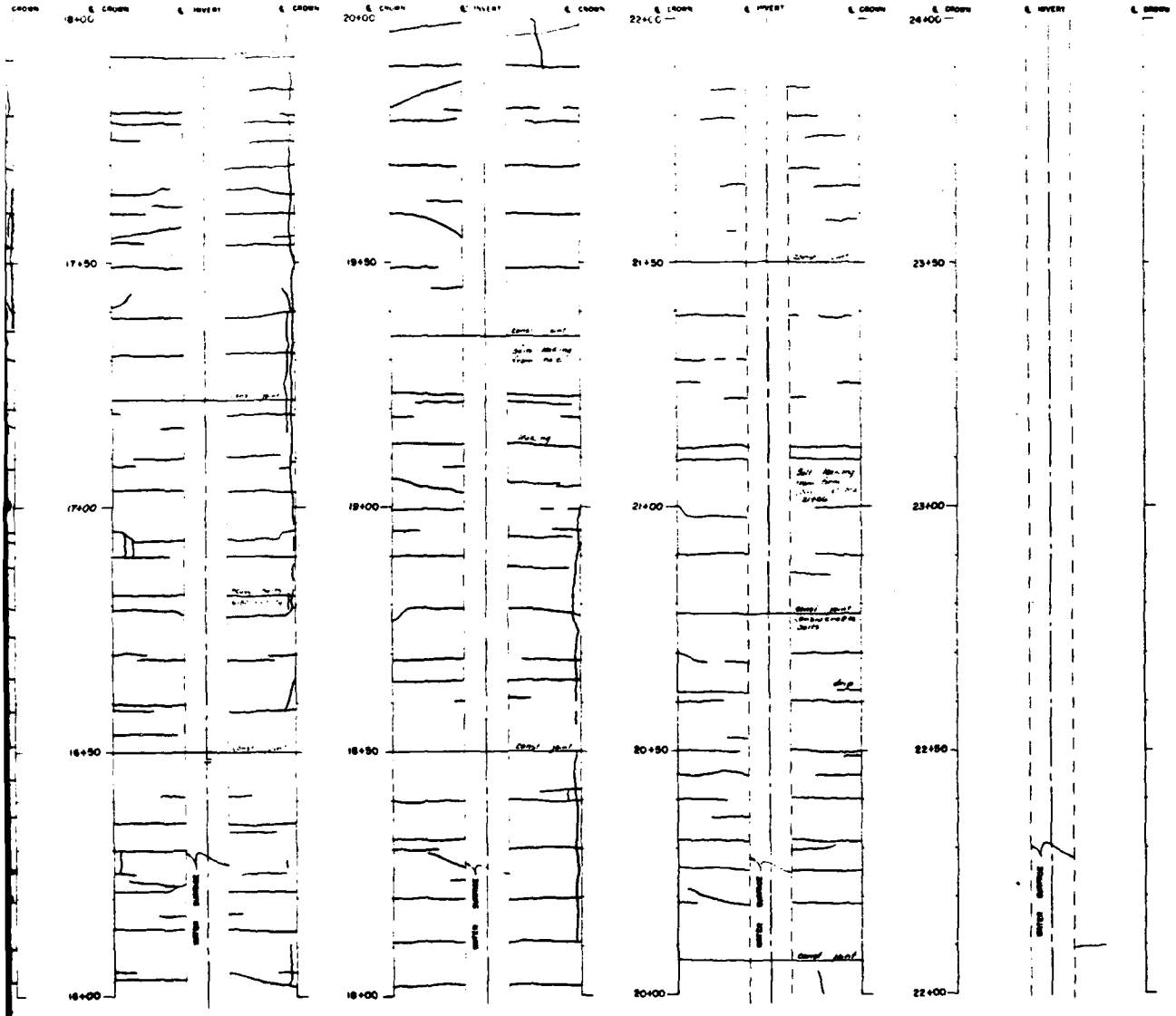
Note:
All cracks filled with salts and no cracks were found to exceed 1/8 inch in width.
Almost all cracks were leaking at crown between 0+50 and 2+00.
Tunnel inspection made 26 May, 1956

Scale
Horizontal 1" = 10'
Circumferences 1" = 20'


℄ Crown
℄ Invert
℄ Crown
4+00
5+00
5+50
6+00
6+50
7+00
7+50
8+00
8+50
9+00
9+50
10+00
10+50
11+00
11+50
Water Surface
Scale
Horizontal 1" = 10'
Circumference 1" = 20'
CRACK INSPECTION
TUNNEL NO. 4
May 1956
6-10-E.1-1-105

2


℄ CROWN
℄ INVERT
℄ CROWN
14+00
13+50
13+00
12+50
12+00
15+50
15+00
14+50
14+00
17+50
17+00
16+50
16+00
19+50
19+00
18+50
18+00
20+00
21+50
21+00
20+50
20+00
SCALE
Horizontal 1" = 10'
Circumferential 1" = 20'
NOTE



SCALE

Horizontal 1" = 10'
Longitudinal 1" = 50'

NOTE

All cracks were filled with grout and no cracks were found to exceed 1/8 inch in width. Tunnel inspection made 26 June 1956

REVISION	DATE	DESCRIPTION	BY

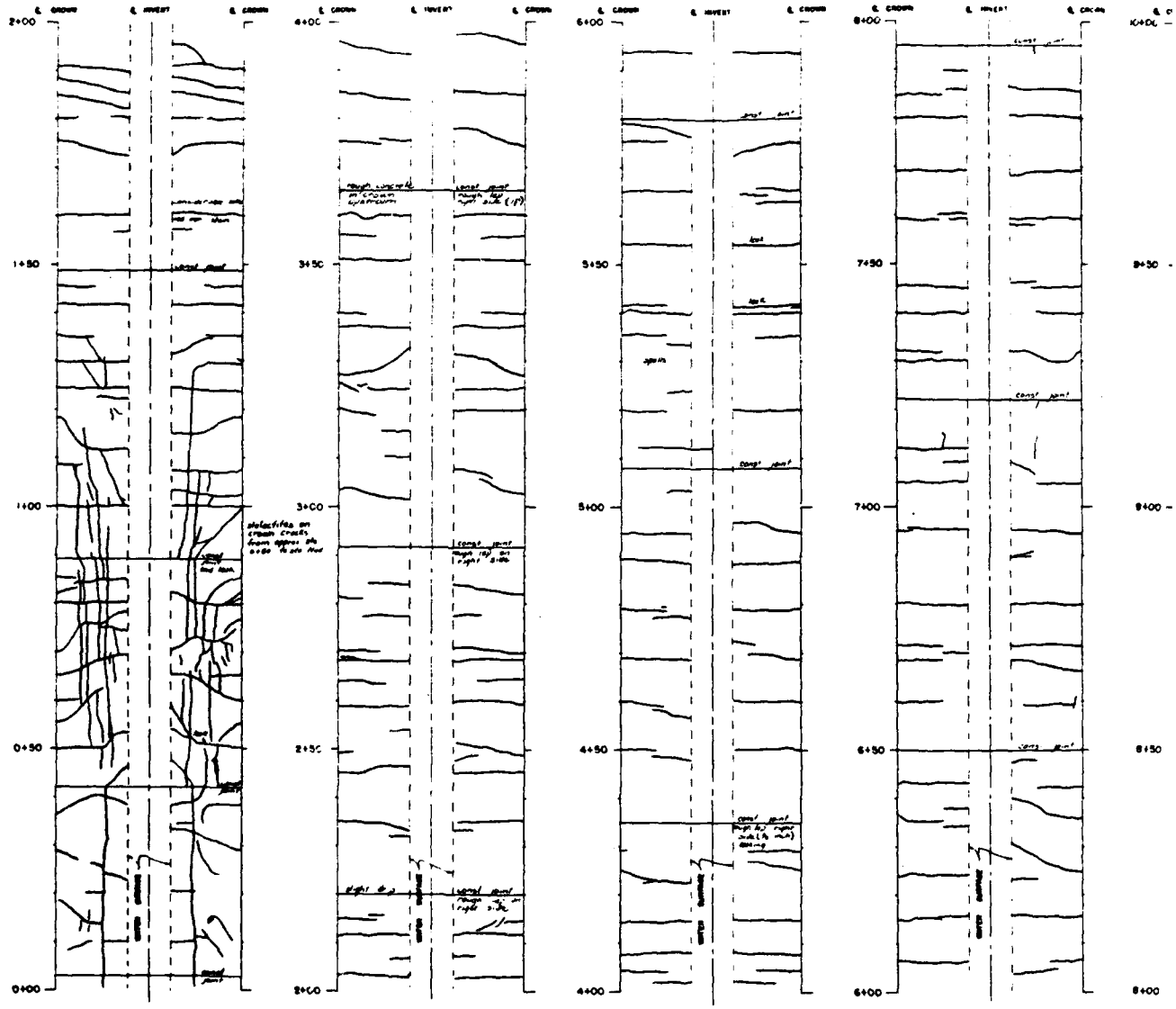
CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
FORT PECK DISTRICT
FORT PECK, MONTANA

DRAWN BY JLP
TRACED BY JLC
DESIGNED BY
CHECKED BY
CHIEF DESIGNER
CHIEF ENGINEER

CRACK INSPECTION TUNNEL NO. 3

DATE JUNE 1956

SCALE
DRAWING NO 6165.1-1-110
SHEET 2 OF 2

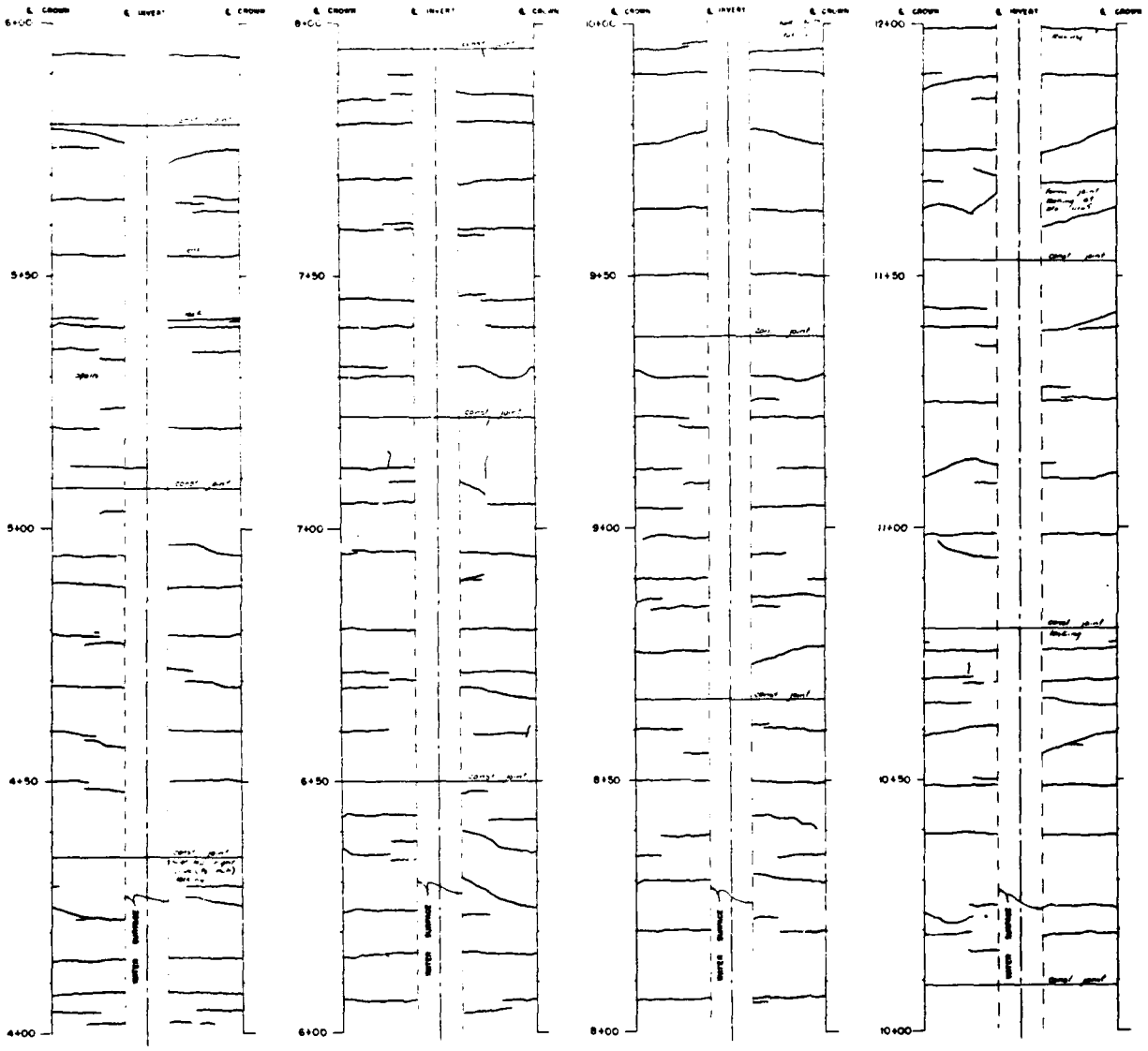


Note Almost all cracks were leaking at crown between 0+00 and 2+00

Note

All cracks were filled with salts and no cracks were exceed ⅛ inch in width

Tunnel inspection made 20 June 1976



SCALE

Horizontal 1" = 10'
Circumference 1" = 20'

Note

All cracks were filled with soil and no cracks were found to exceed ⅛ inch in width.
Tunnel inspection made 20 June 1956

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
FORT PECK DISTRICT
FORT PECK, MONTANA

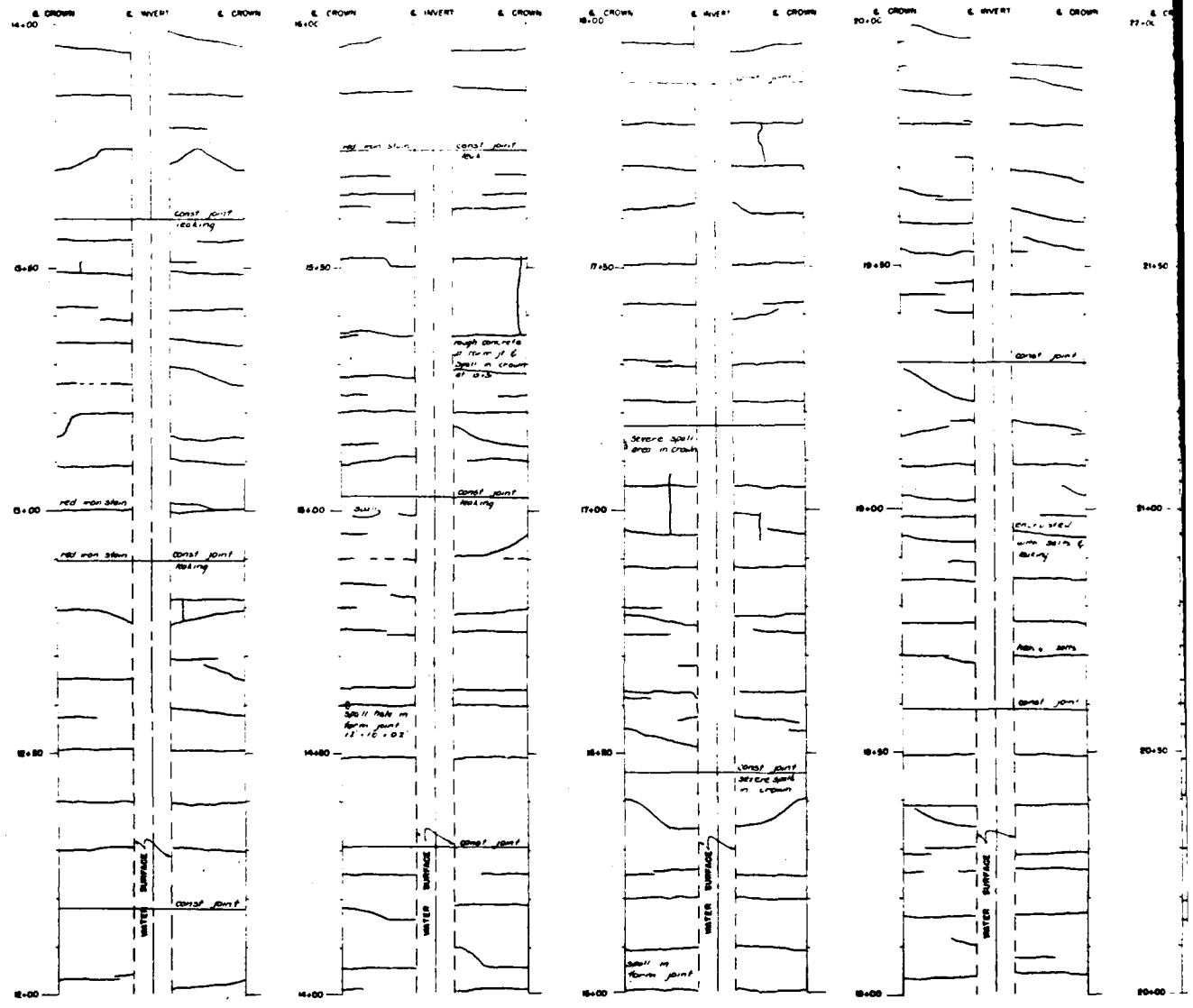
CRACK INSPECTION
TUNNEL NO. 3

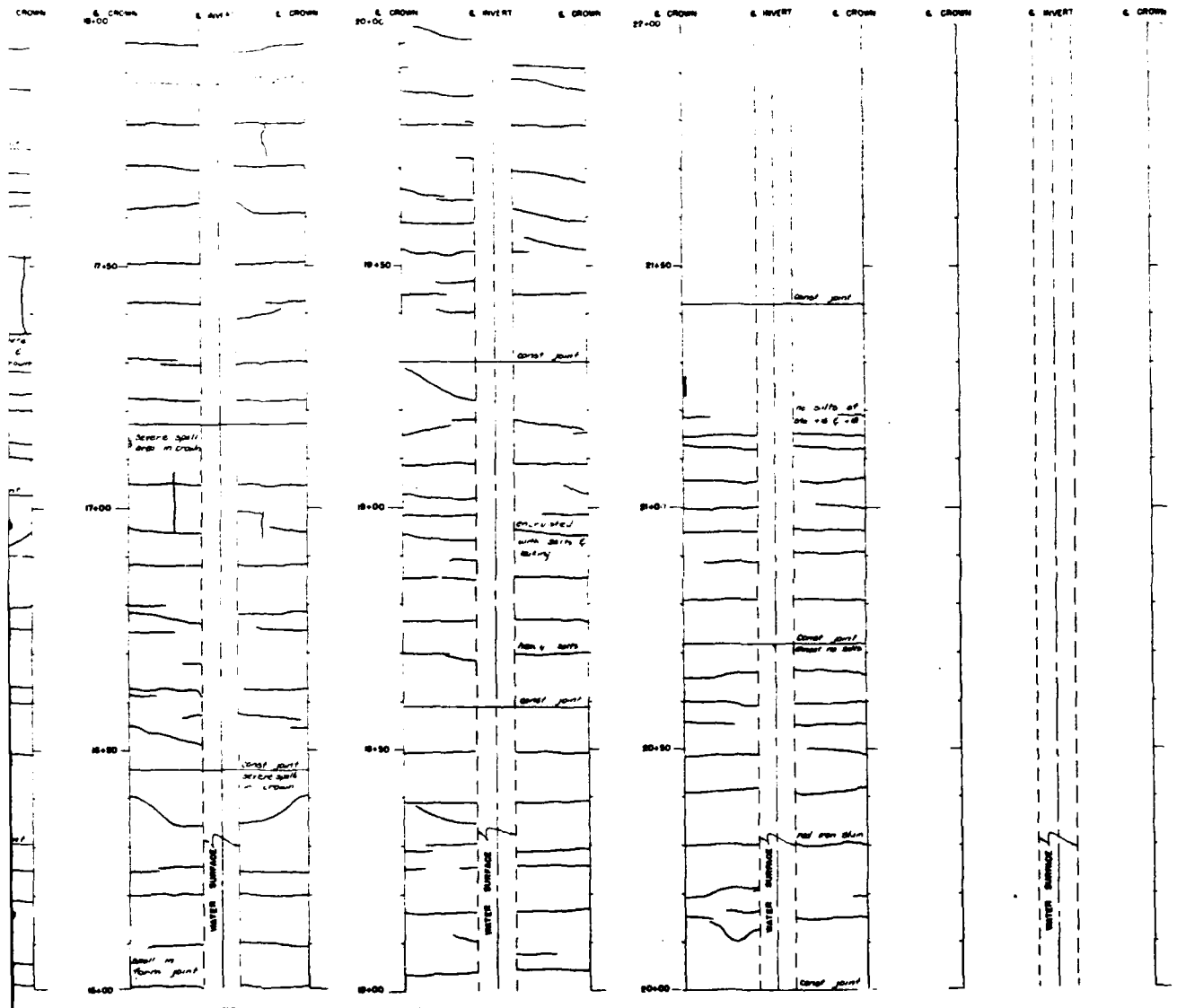
JUNE 1956

DRAWING NO. 6-103.1-1-109

SHEET 1 of 2

2


℄ CROWN
℄ INVERT
℄ CROWN
14+00
15+50
15+00
14+50
14+00
16+00
15+50
15+00
14+50
14+00
17+50
17+00
16+50
16+00
19+50
19+00
18+50
18+00
21+50
21+00
20+50
20+00
WATER SURFACE
const joint leaking
red iron stain
rough concrete at form jt. & spall in crown at 0+35
spall
spall hole in form joint 13'-16'+0.2'
const joint
severe spall area in crown
spall in form joint
severe spall in crown
cracked with salts & leaking
hairline cracks
SCALE
Vertical 1" = 10'
Circumference 1" = 50'
NOTE:
All cracks filled with salts & no cracks were found in
Tunnel inspection made 6 July 1956



SCALE
Horizontal 1" = 10'
Circumference 1" = 20'

NOTE:
All cracks filled with salts & no cracks were found to exceed 1/8" in width
Tunnel inspection made 6 July [illegible]

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
FORT PECK DISTRICT
FORT PECK, MONTANA

JVB
JVB
C.W.

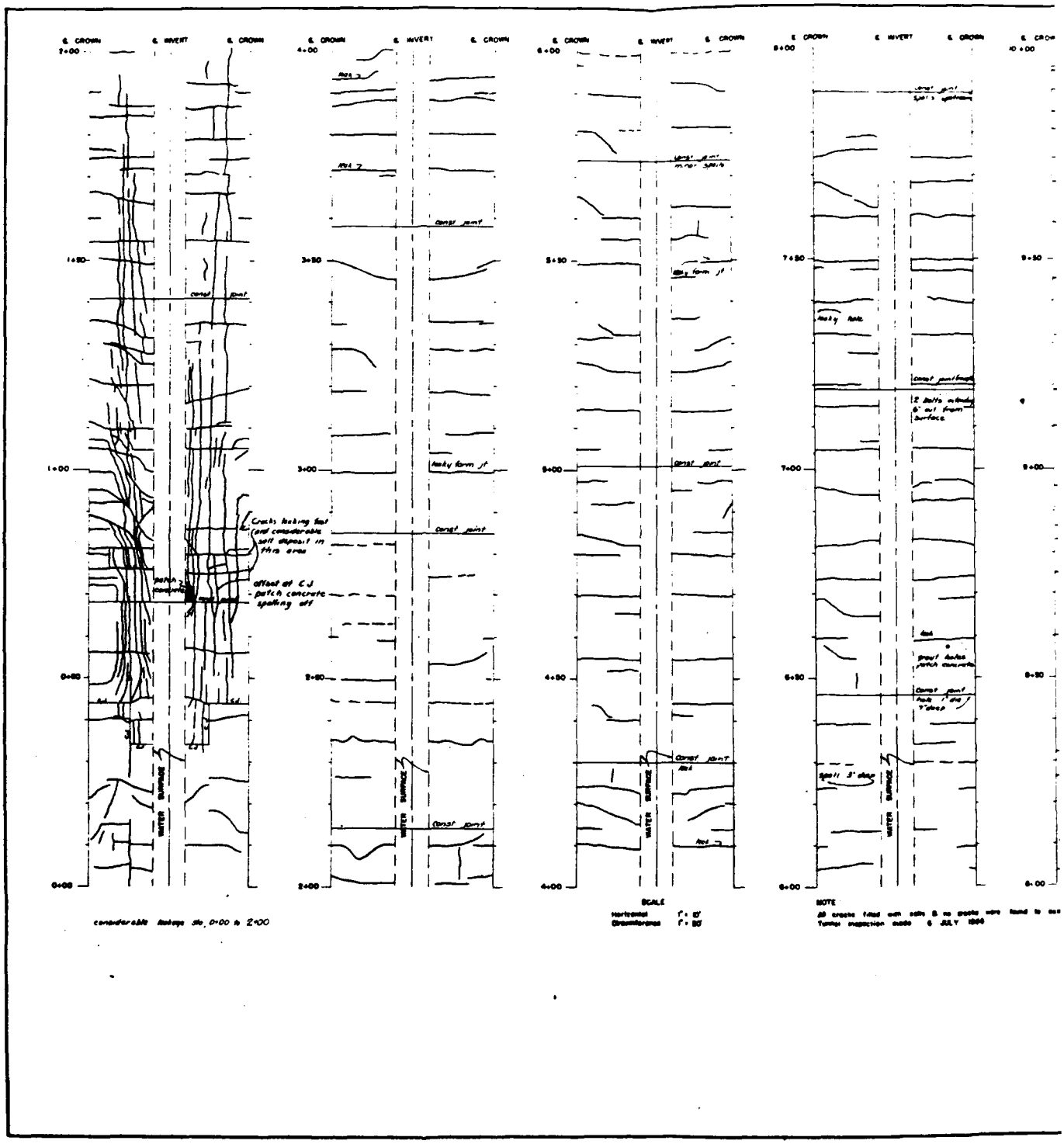
CRACK INSPECTION
TUNNEL NO. 2

JULY [illegible]

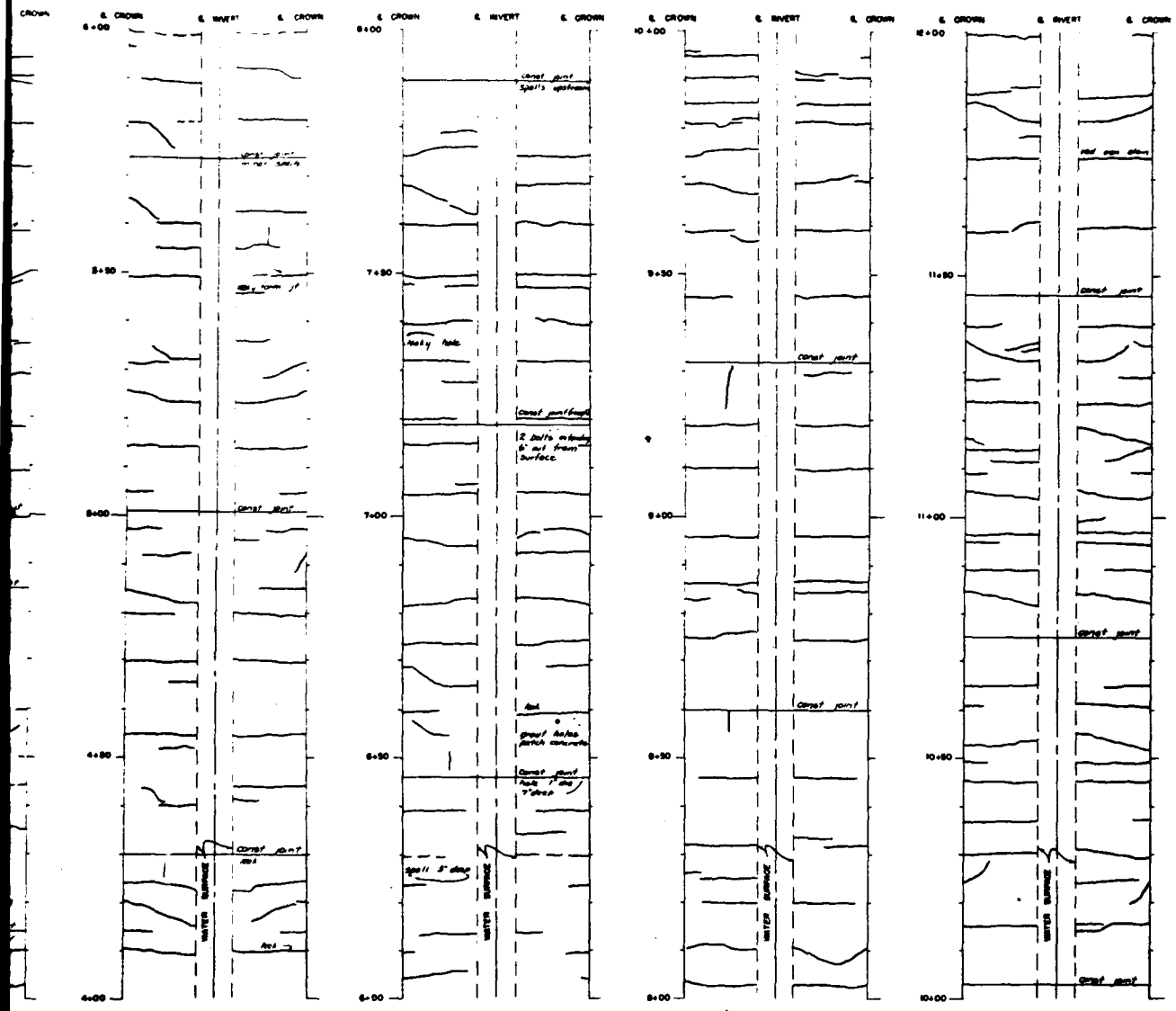
SHEET 2 OF 2

CONSTRUCTION FOUNDATION REPORT PLATE 191

2



considerable leakage sta. 0+00 to 2+00



SCALE

horizontal 1" = 10'
diagonal 1" = 50'

NOTE

All cracks filled with salts & no cracks were found to exceed 1/8" in width
Tunnel inspection made 6 JULY 1966

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS, U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
FORT PECK DISTRICT
FORT PECK, MONTANA

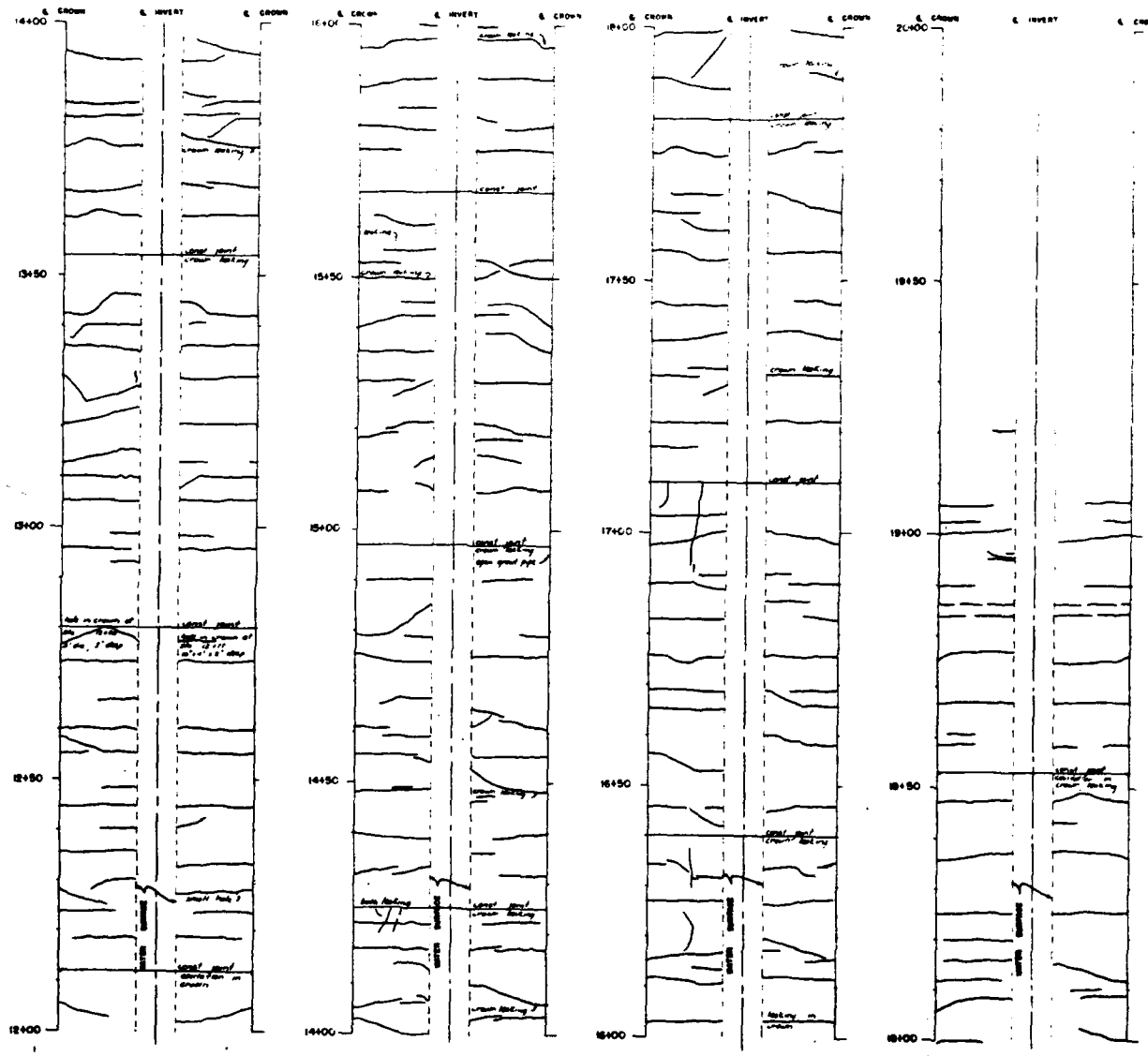
DRAWN BY JVB
TRACED BY JVB
CHECKED BY C.W.J.

CRACK INSPECTION
TUNNEL NO. 2

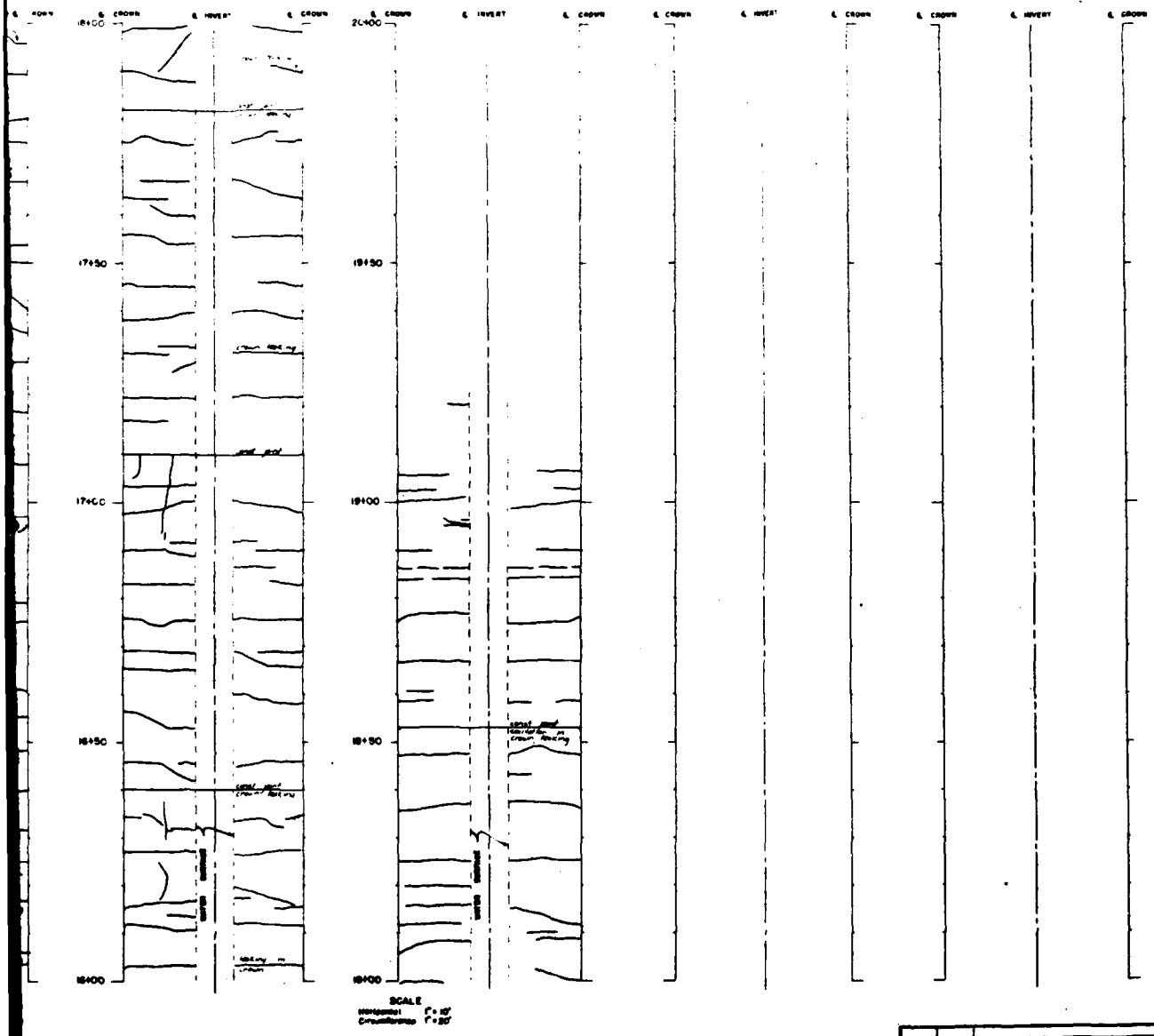
JULY 1966

SHEET 1 OF 2

2



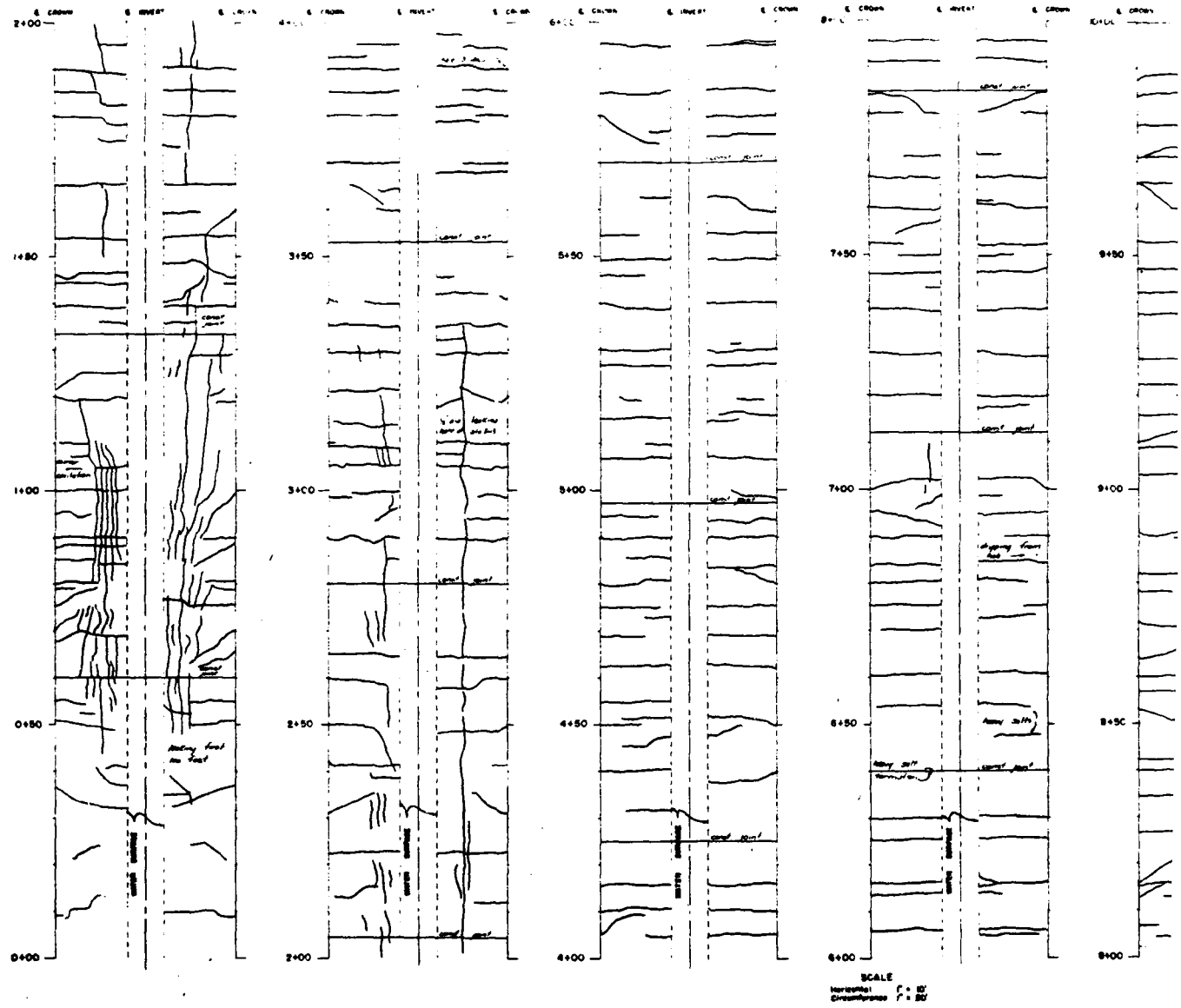
Note:
All voids filled
were found in
Tunnel inspect



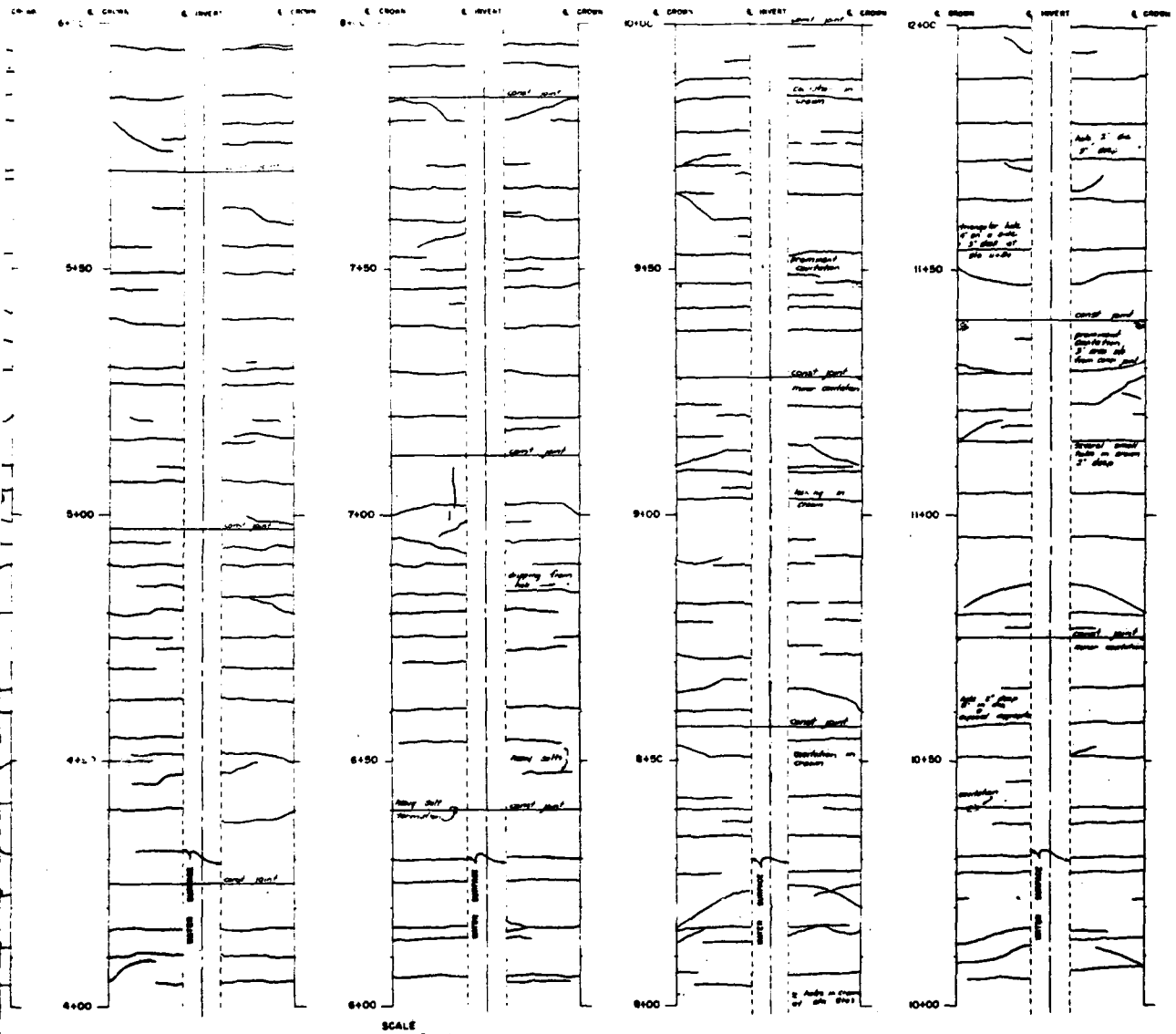
Note:
All cracks filled with salts and no cracks were found to exceed 5" in width
Tunnel inspection made 10 June 1956

CRACK INSPECTION
TUNNEL NO. 1

2



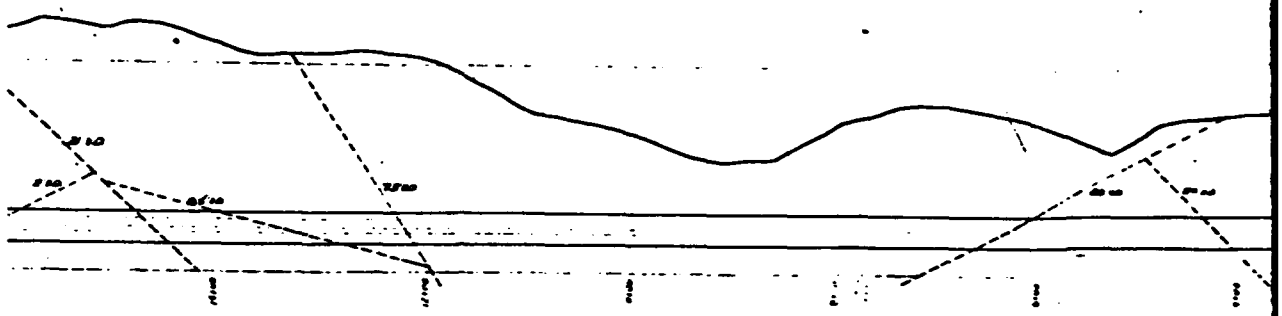
Note:
All cracks filled with
were found to exceed
Tunnel inspection



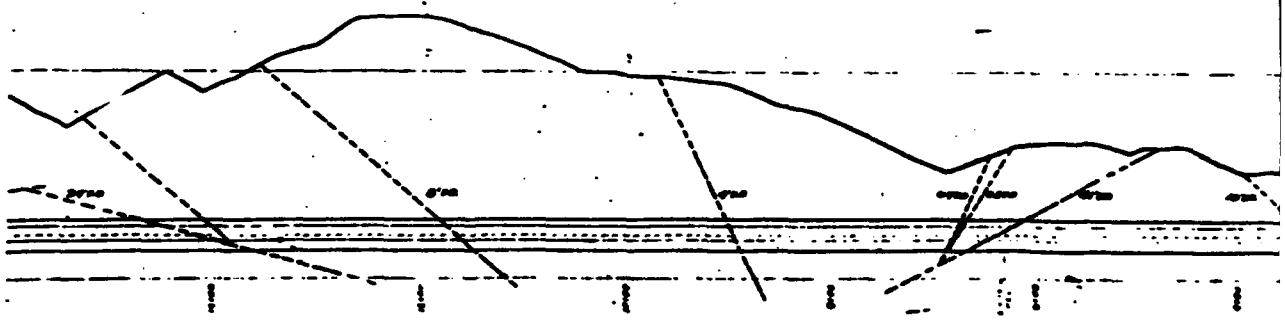
Note
All cracks filled with salts and no cracks were found to exceed ⅛" in width
Tunnel inspection made 10 June 1956

REVISION	DATE	DESCRIPTION	BY
		CORPS OF ENGINEERS, U.S. ARMY OFFICE OF THE DISTRICT ENGINEER FORT PECK, MONTANA	
DESIGNED BY JVB DRAWN BY JVB CHECKED BY C.V.J.		CRACK INSPECTION TUNNEL NO. 1	
		JUNE 1956	
		SCALE AS SHOWN	
		SHEET 1 of 2	

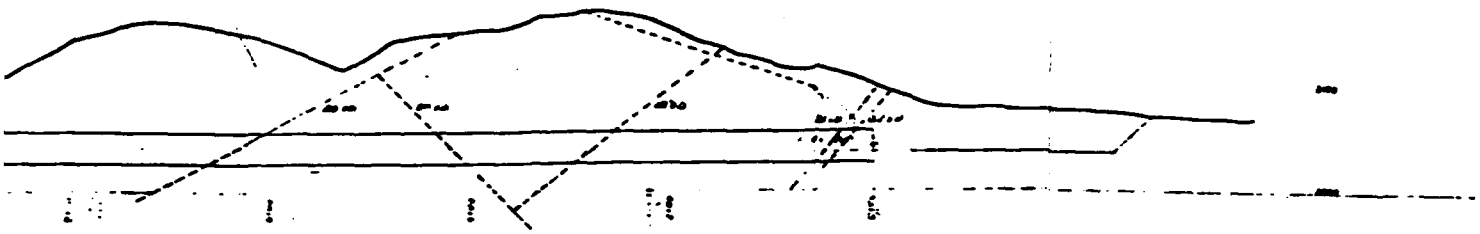
2



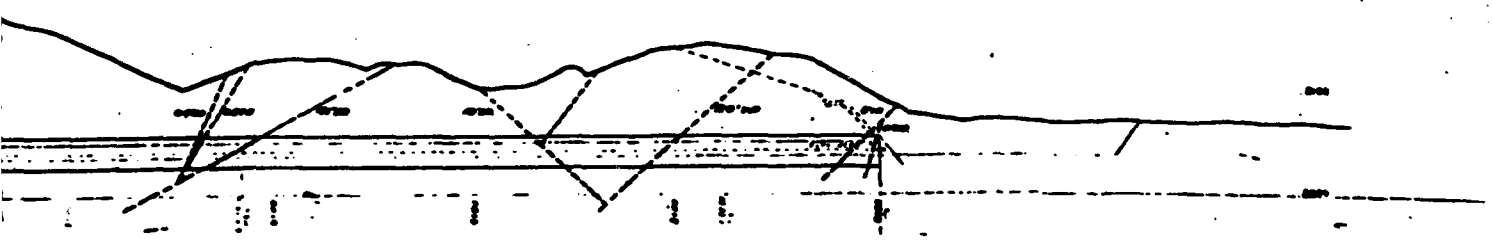
TUNNEL NO. 2
Sta. 0+00 to Sta. 1



TUNNEL NO. 1

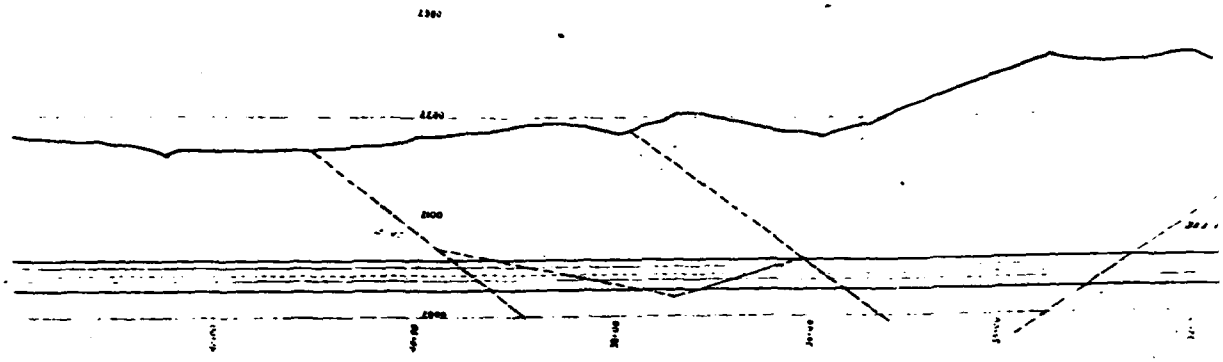


TUNNEL NO. 2
Sta. 0+00 to Sta. 16+00



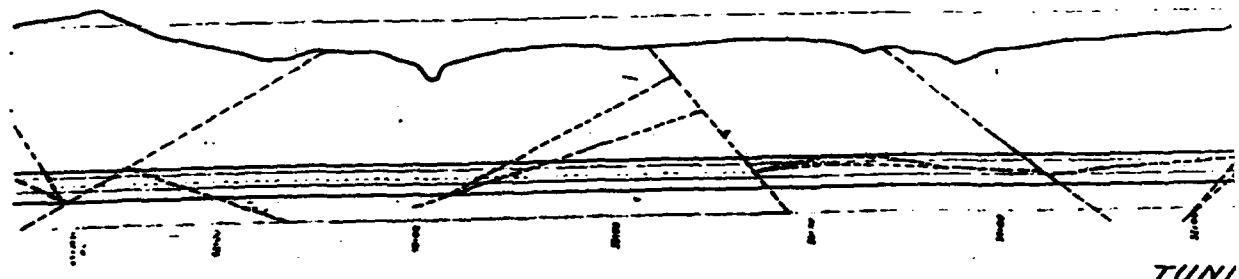
TUNNEL NO. 1

2



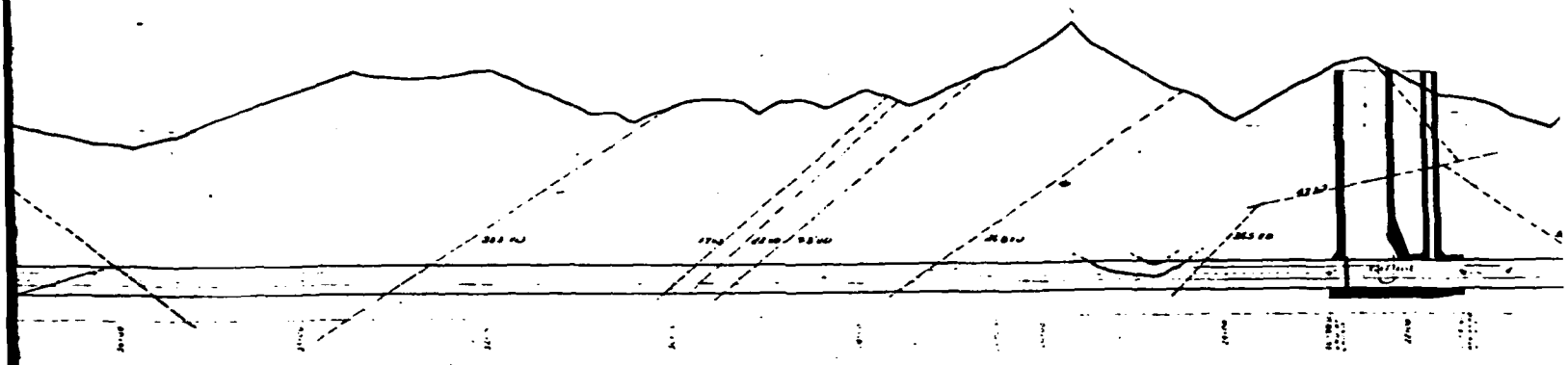
TUNNEL
Sta. 16+00

SCALE
FAULTS
VERTICAL
13' BENTO



TUNI

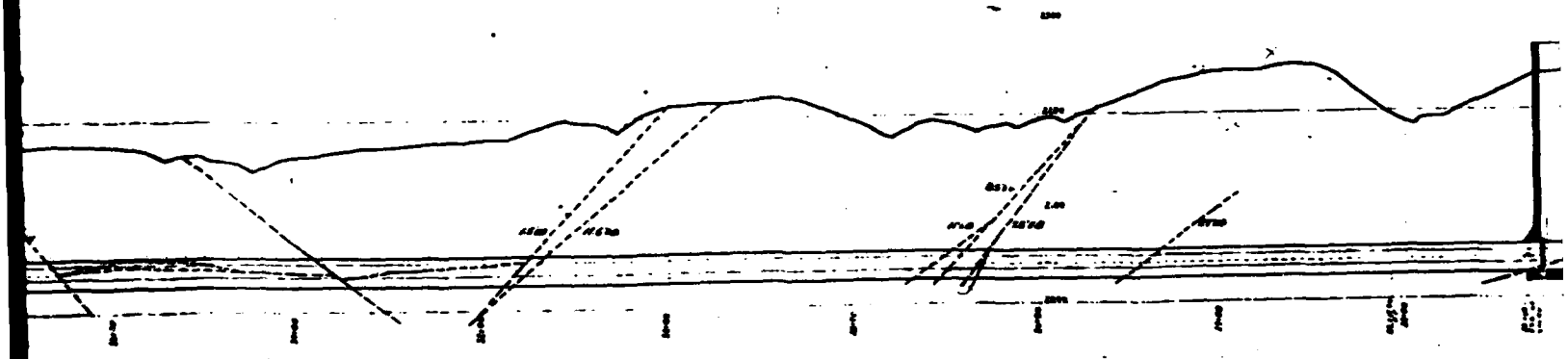
SCALE: 1"



TUNNEL NO. 2
Sta. 16+00 to Sta. 44+00

SCALE: 1"=80'

FAULTS SHOWN
VERTICAL DISPLACEMENT - V.D.
45° BEDDING SITE BED

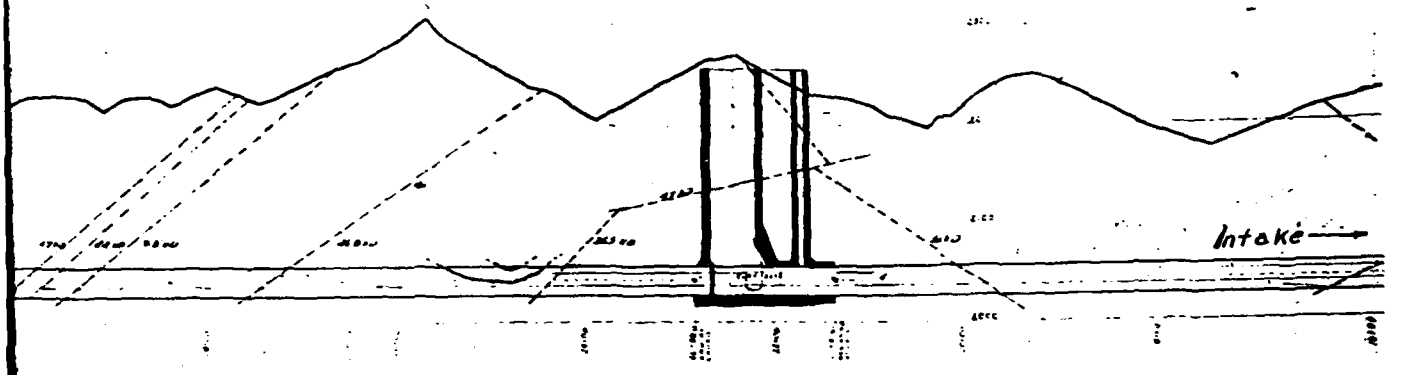


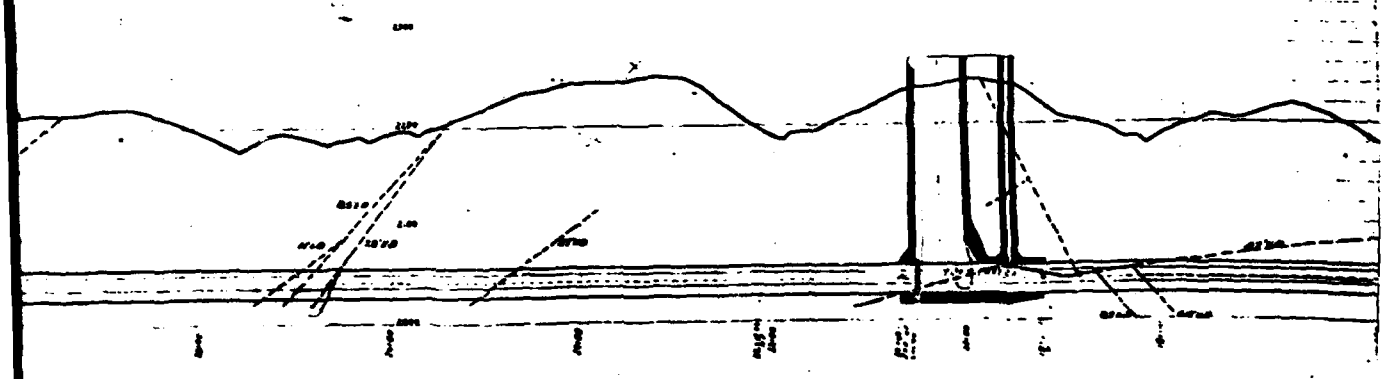
TUNNEL NO. 1

SCALE: 1"=80'

2

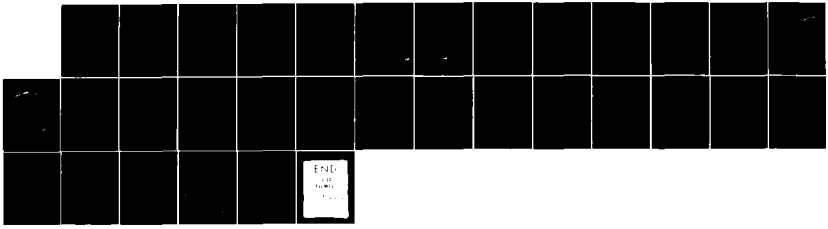
CONS

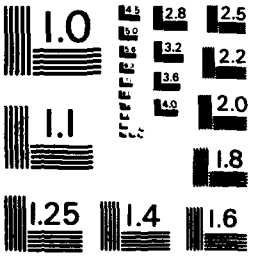

Intake



AD-A134 915 CONSTRUCTION FOUNDATION REPORT MISSOURI RIVER FORT PECK LAKE MONTANA VOLUME 3 DRAWINGS(U) CORPS OF ENGINEERS OMAHA NE JAN 83 2/2

UNCLASSIFIED F/G 13/13 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

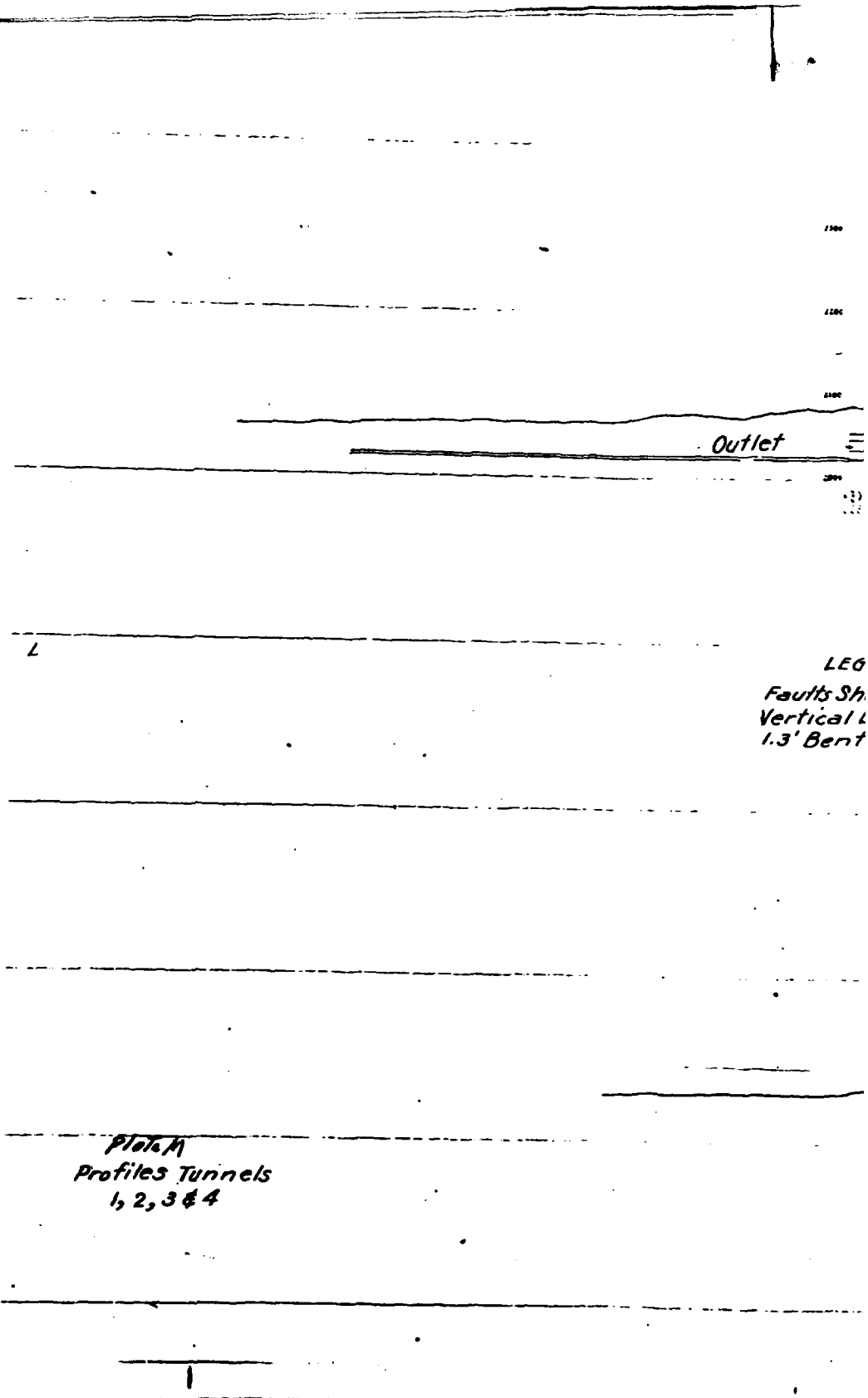
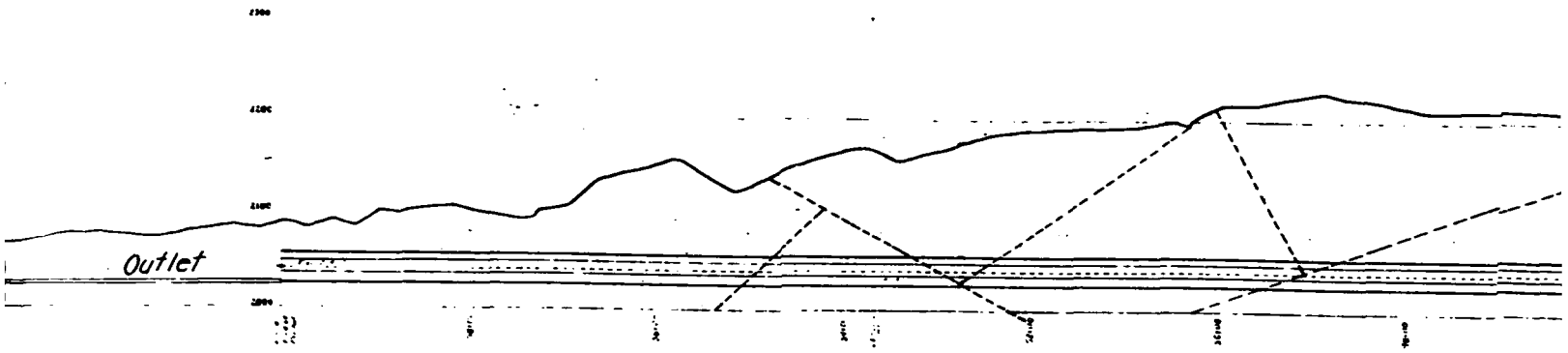


Plate M
Profiles Tunnels
1, 2, 3 & 4

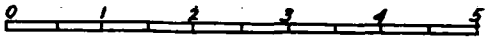


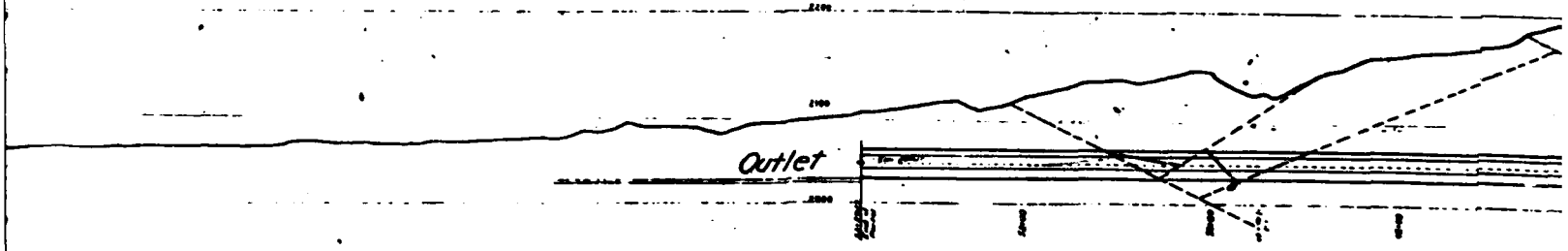
TUNNEL NO. 2
Sta. 44+00 To End
Scale 1" = 80'

LEGEND

Faults Shown - - - -
Vertical Displacement V.D.
1.3' Bentonite Bed —

GRAPHIC SCALE

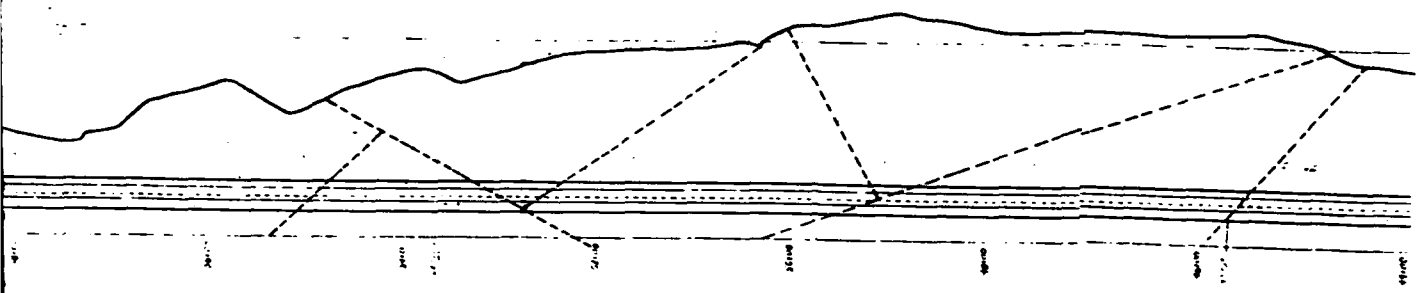




TUNNEL NO. 1
Sta. 44+00 To End
Scale 1" = 80'

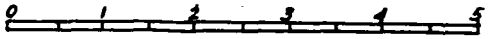
2

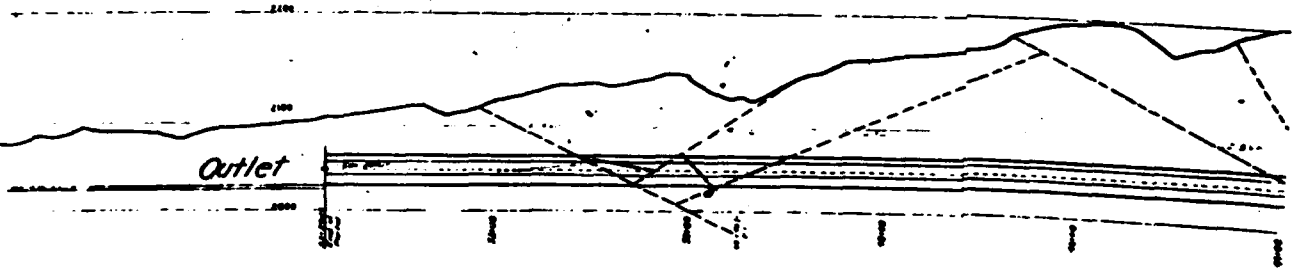
CONSTRUCTION FOUNDATI



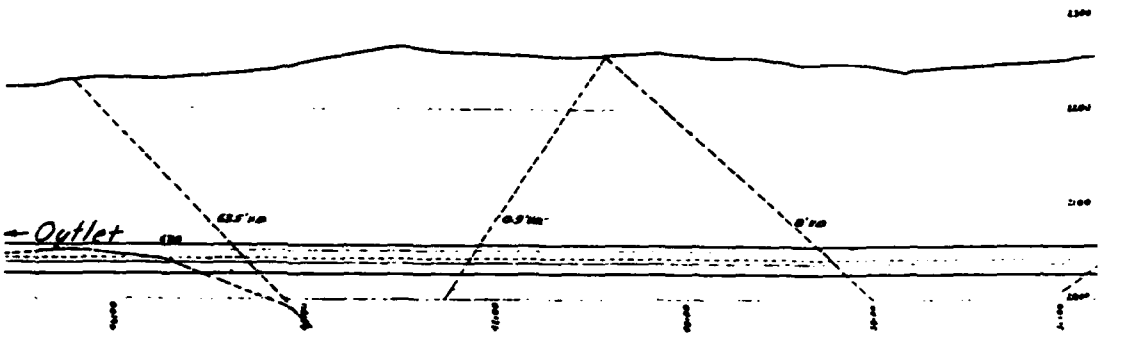
TUNNEL NO. 2
Sta. 44+00 To End
Scale 1" = 80'

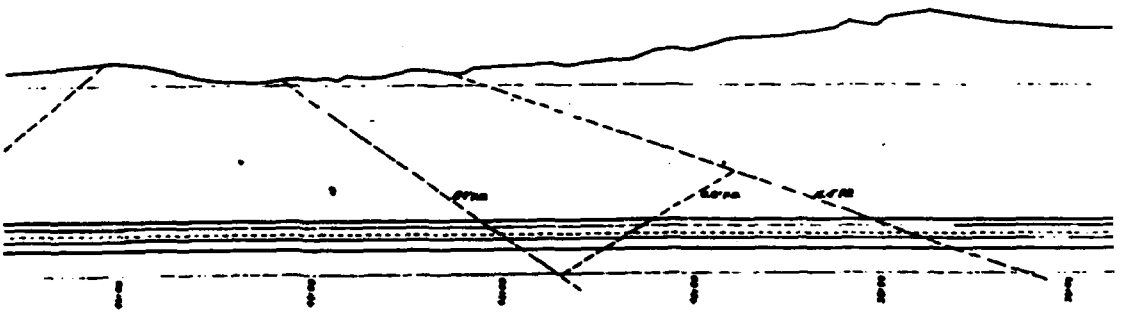
GRAPHIC SCALE

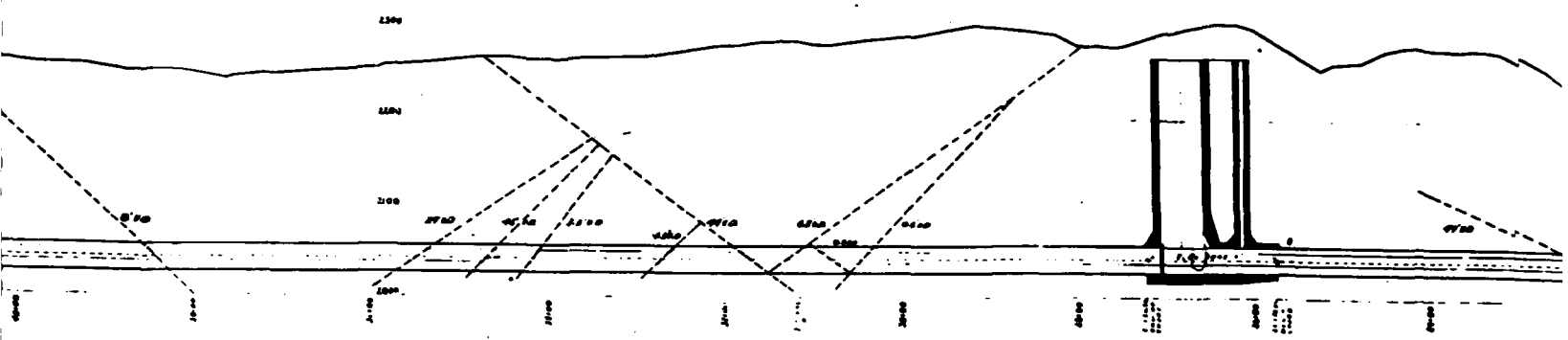




TUNNEL NO. 1
Sta. 44+00 To End
Scale 1" = 80'


Outlet

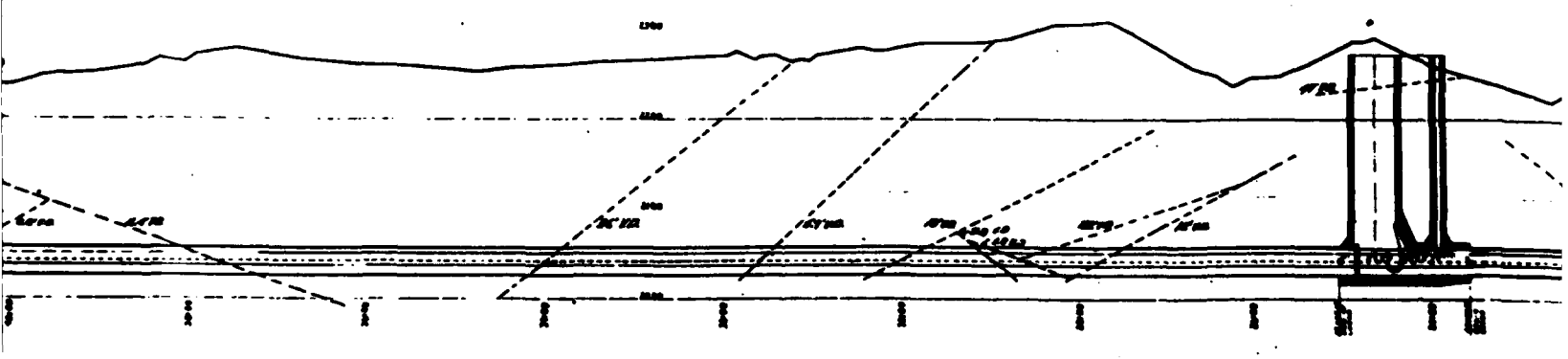




TUNNEL NO. 4
Sta. 18+00 TO Sta 46+00

SCALE 1"=80'

FAULTS SHOWN - - - - -
VERTICAL DISPLACEMENT · U.D.
13' BENTONITE BED ——

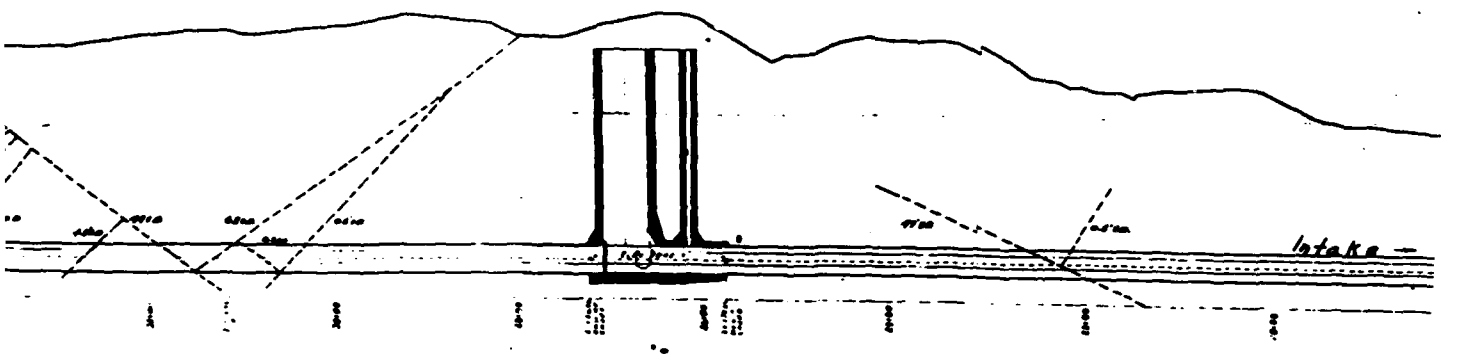


TUNNEL NO.3

SCALE: 1"=80'

2

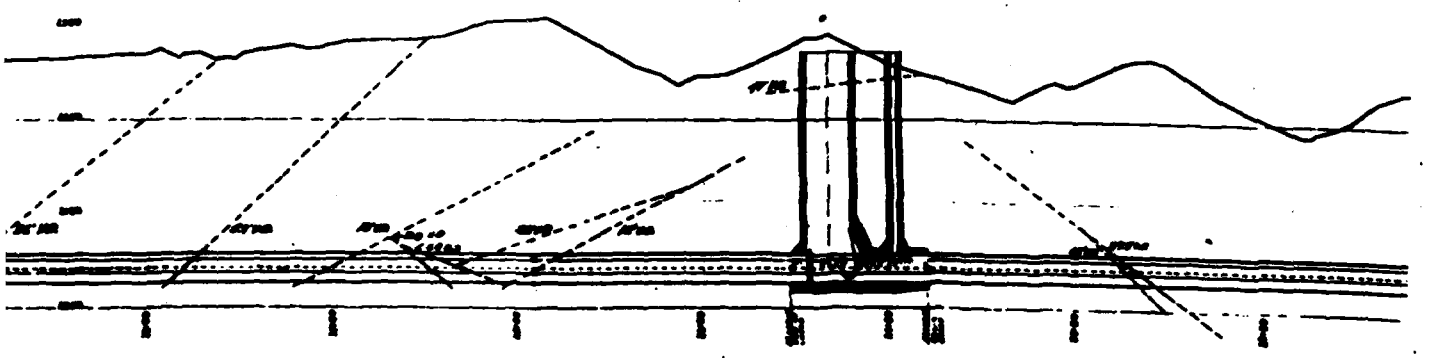
CONSTRUC



TUNNEL NO. 4
Sta. 18+00 TO Sta 46+00

SCALE 1"=80'

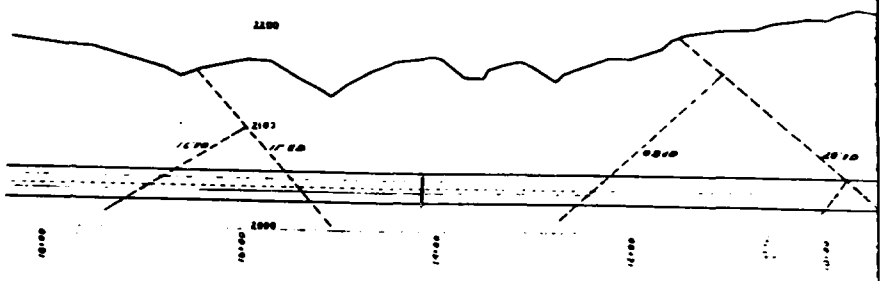
FAULTS SHOWN - - - - -
VERTICAL DISPLACEMENT - 1.0
1.3' BENTONITE BED ——

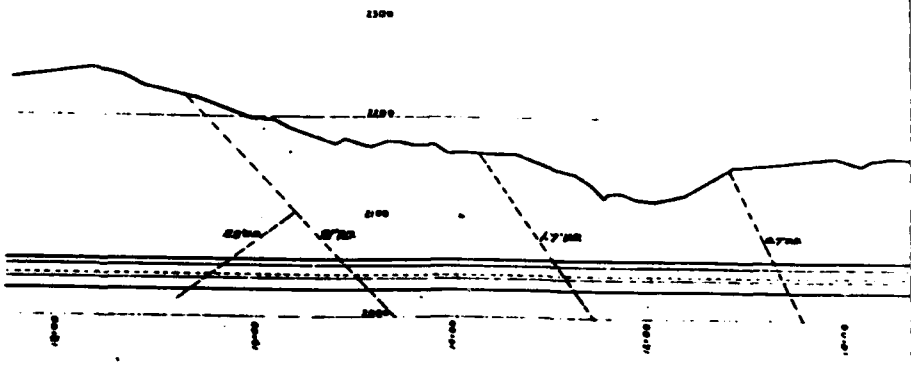


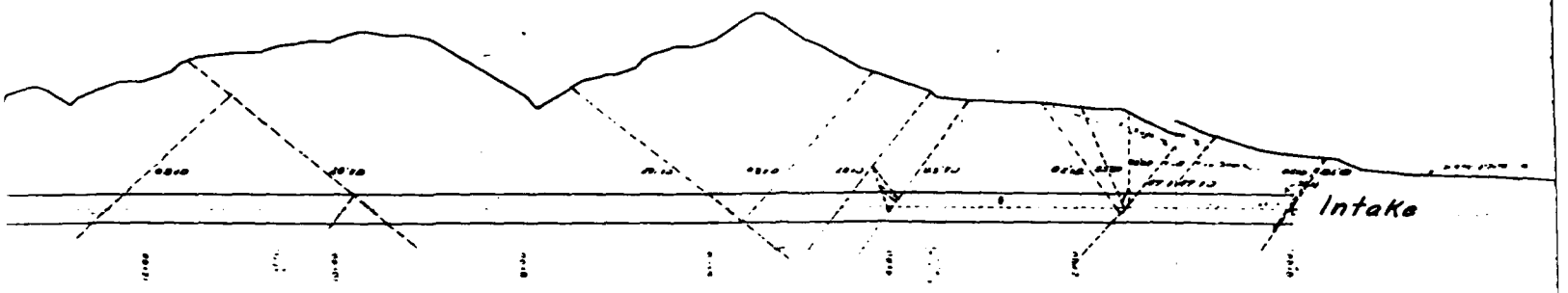
TUNNEL NO.3

SCALE: 1"=80'

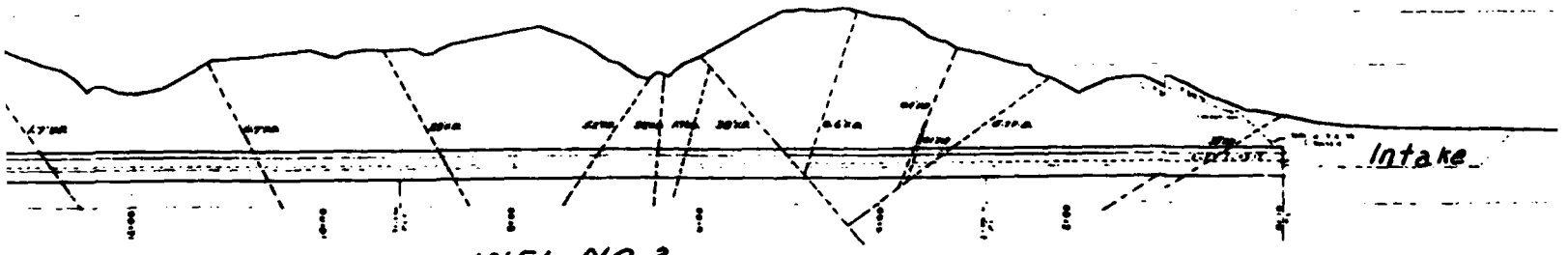
2



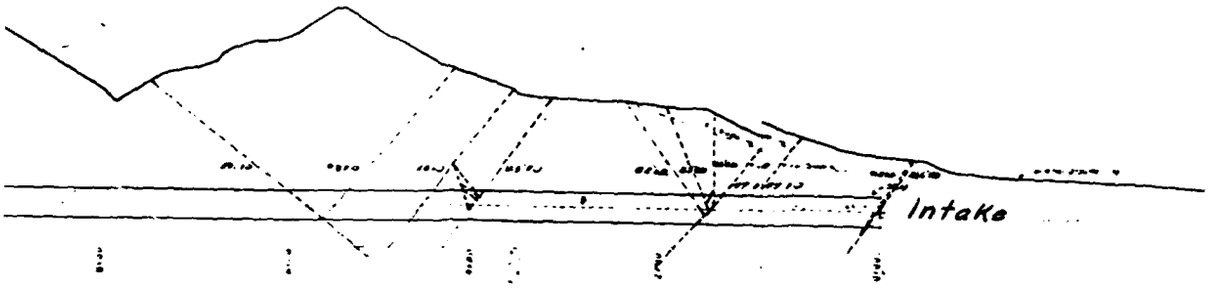




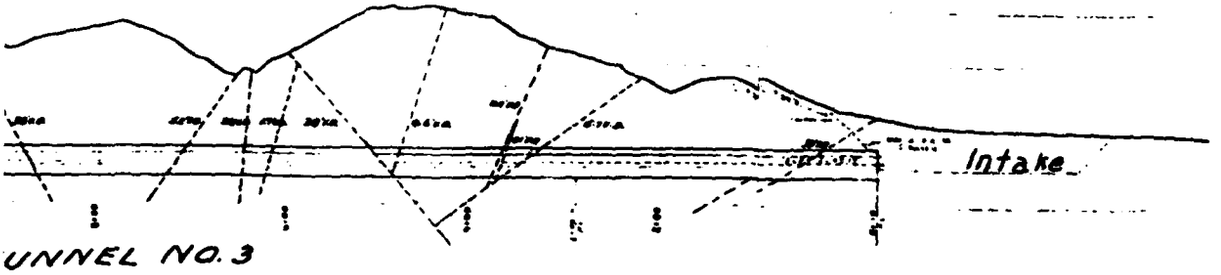
TUNNEL NO.4
Sta. 46+00 to End



TUNNEL NO.3



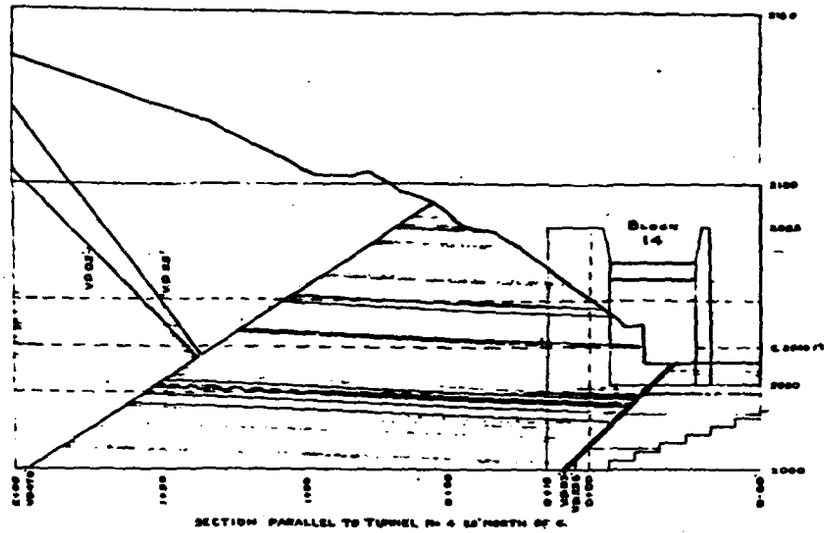
'NNEL NO.4
46+00 to End



UNNEL NO.3

2

3

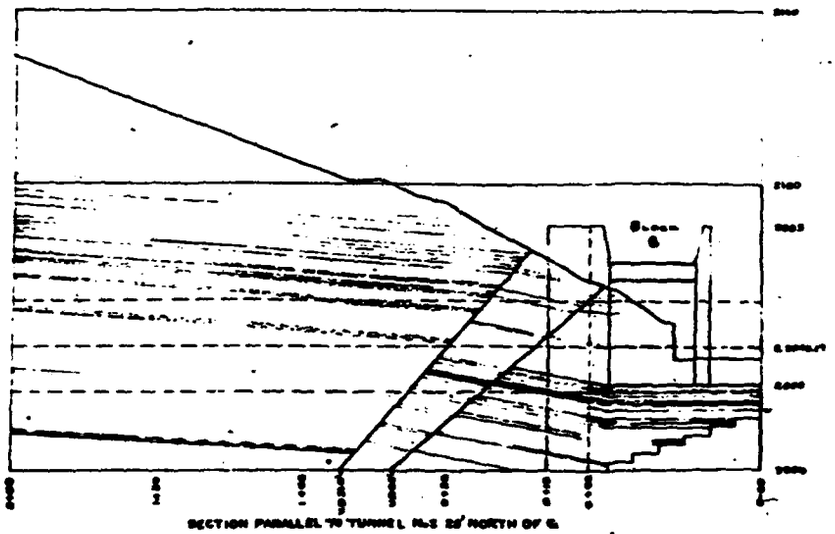


SECTION PARALLEL TO TUNNEL No 4 50' NORTH OF ℄

UPPER PORTALS

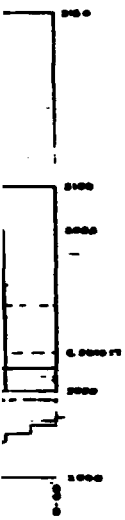
VERTICAL SECTIONS PARALLEL TO TUNNELS

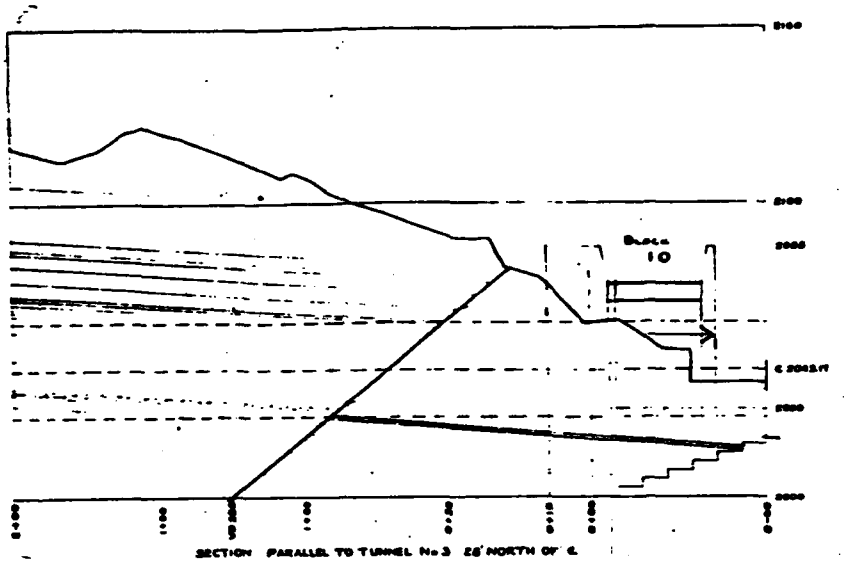
SHOWING GEOLOGIC STRUCTURES



SECTION PARALLEL TO TUNNEL No 5 25' NORTH OF ℄

1			Ground Line Survey	
No	Date	By	Revision	Approved





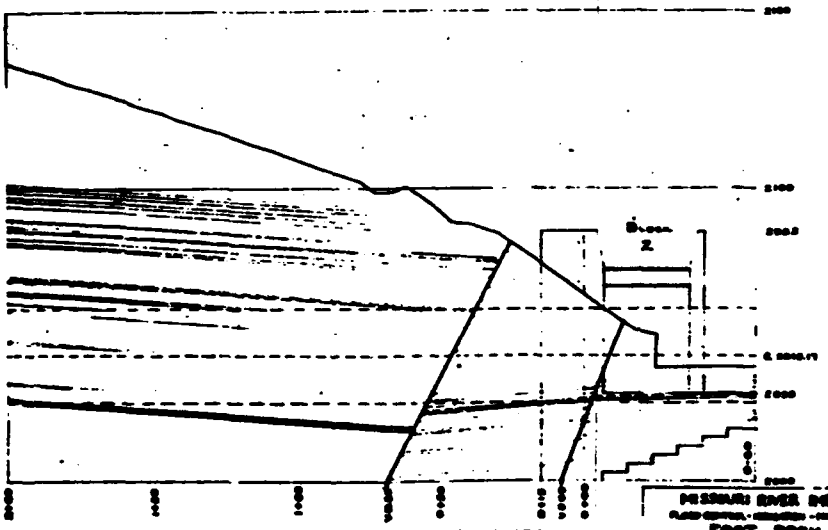
SECTION PARALLEL TO TUNNEL No 3 26' NORTH OF ℄

UPPER PORTALS

VERTICAL SECTIONS PARALLEL TO TUNNELS

SHOWING GEOLOGIC STRUCTURES

Scale in feet



SECTION PARALLEL TO TUNNEL No 1 26' NORTH OF ℄

MISSOURI RIVER IMPROVEMENT

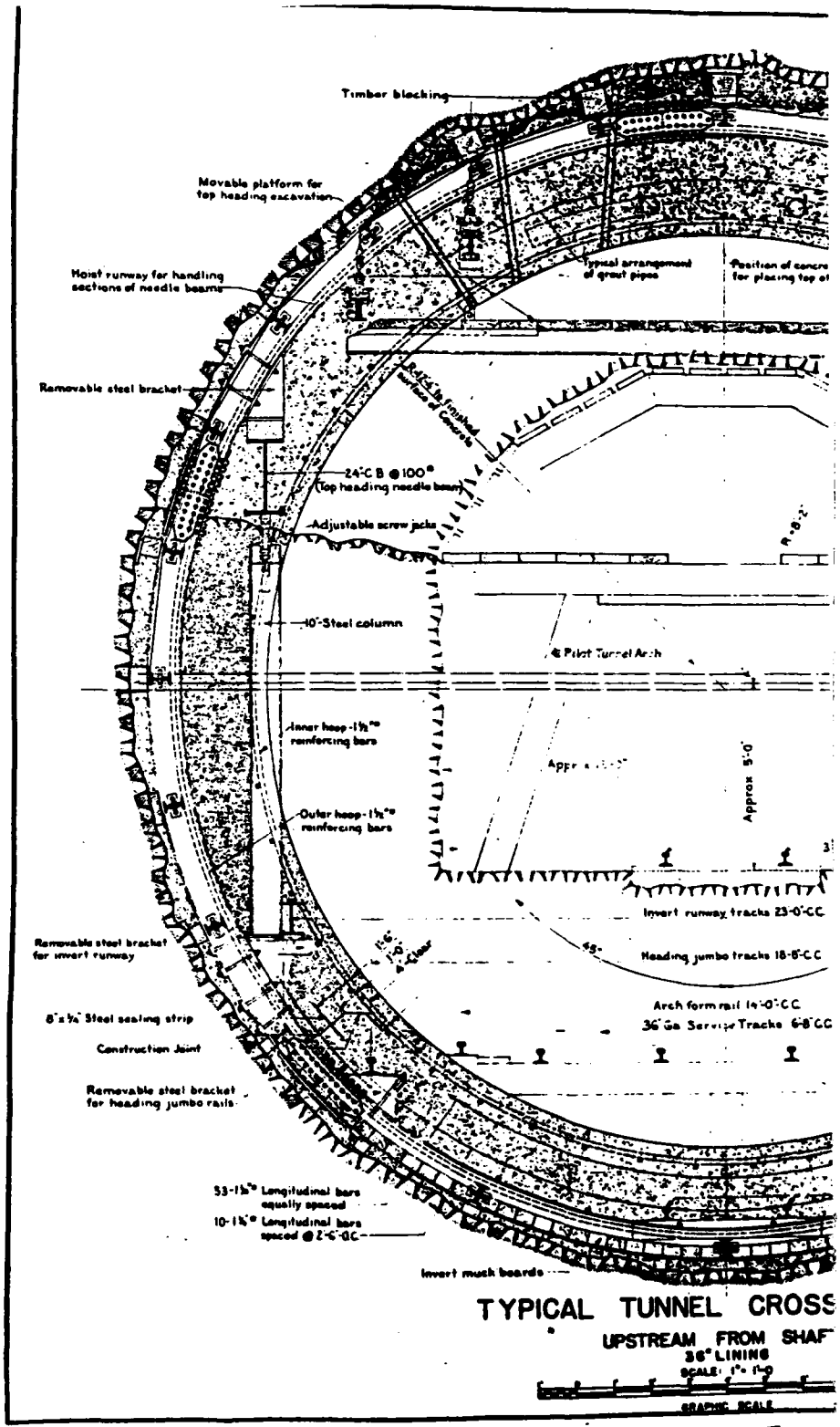
FORT PECK DAM

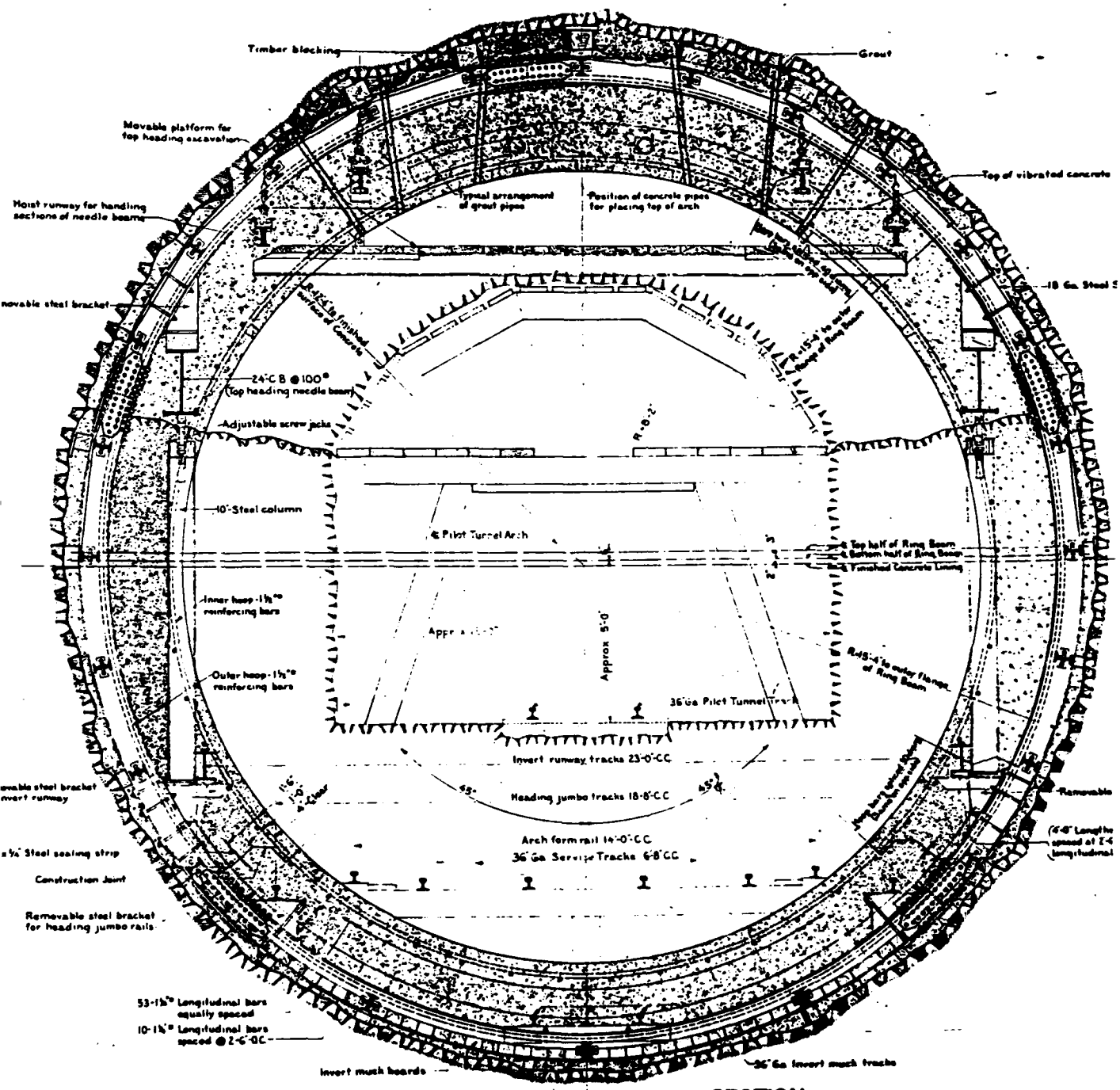
UPPER PORTAL

GEOLOGIC STRUCTURE

Scale 1" = 40'

2


Timber blocking
Movable platform for top heading excavation
Hoist runway for handling sections of needle beams
Typical arrangement of grout pipes
Position of concre for placing top of
Removable steel bracket
Rough finished surface of Concrete
24"CB @100# (Top heading needle beam)
Adjustable screw jacks
10"-Steel column
℄ Pilot Tunnel Arch
Inner hoop-1½" reinforcing bars
Outer hoop-1½" reinforcing bars
Approx 5'-0"
Invert runway tracks 23'-0" CC
Heading jumbo tracks 18'-6" CC
Arch form rail 14'-0" CC
36" Ga Service Tracks 6'-8" CC
Removable steel bracket for invert runway
8" x ¼" Steel sealing strip
Construction Joint
Removable steel bracket for heading jumbo rails
53-1½" Longitudinal bars equally spaced
10-1¼" Longitudinal bars spaced @ 2'-6" CC
Invert mush boards
TYPICAL TUNNEL CROSS
UPSTREAM FROM SHAF
36" LINING
SCALE: 1" = 1'-0"
GRAPHIC SCALE



TYPICAL TUNNEL CROSS SECTION

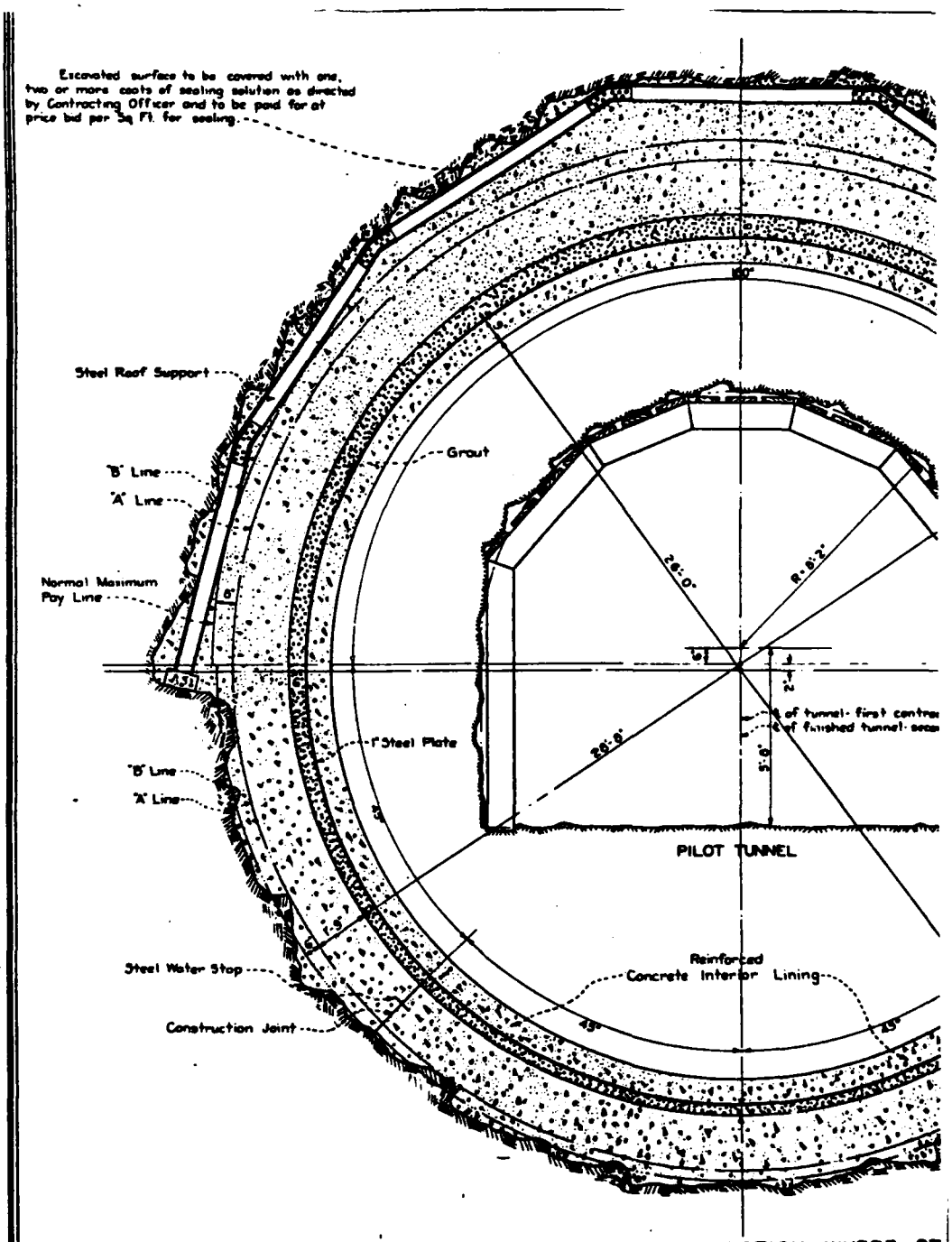
UPSTREAM FROM SHAFTS

36" LINING

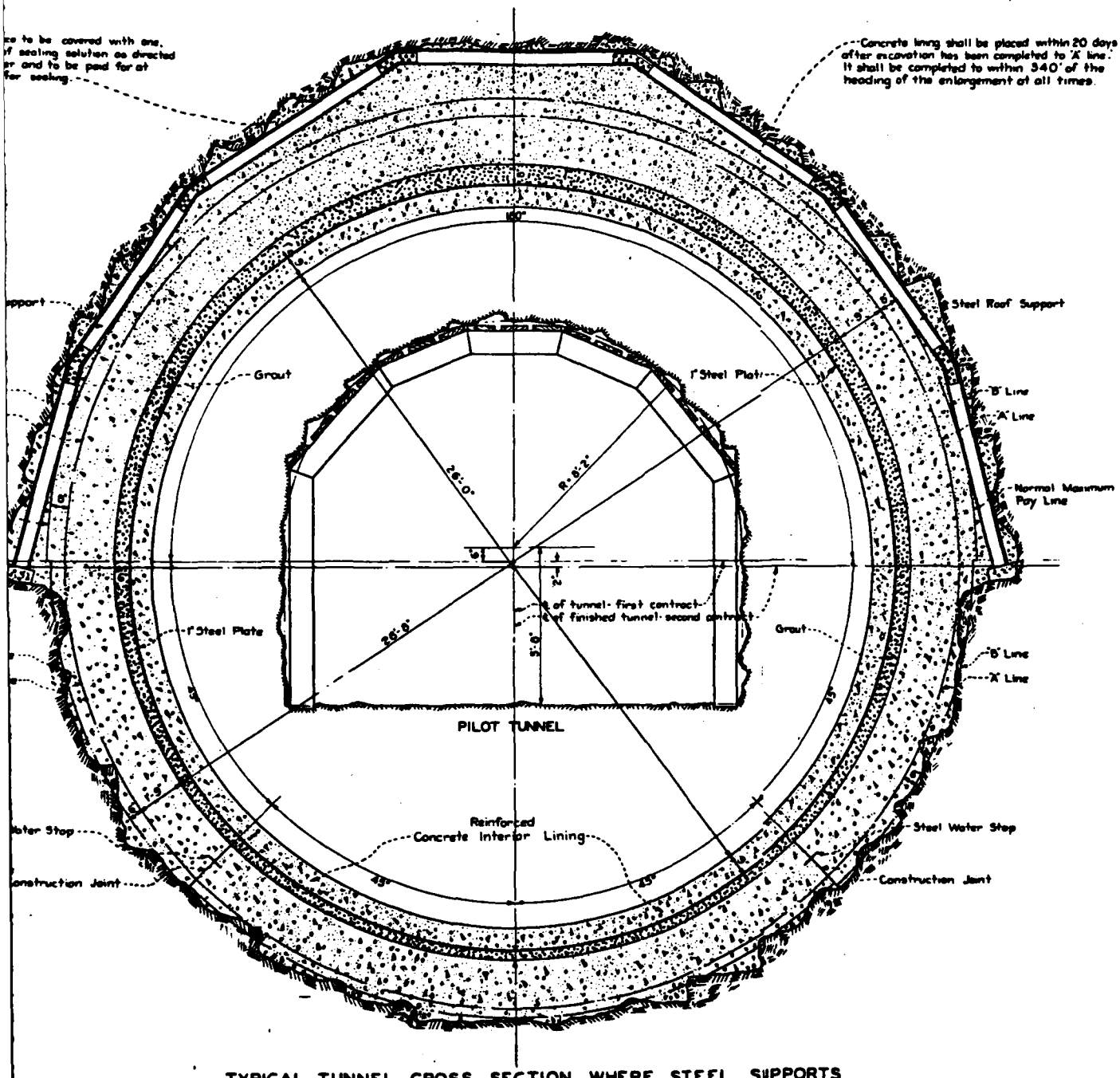
SCALE: 1" = 1'-0"

GRAPHIC SCALE

2



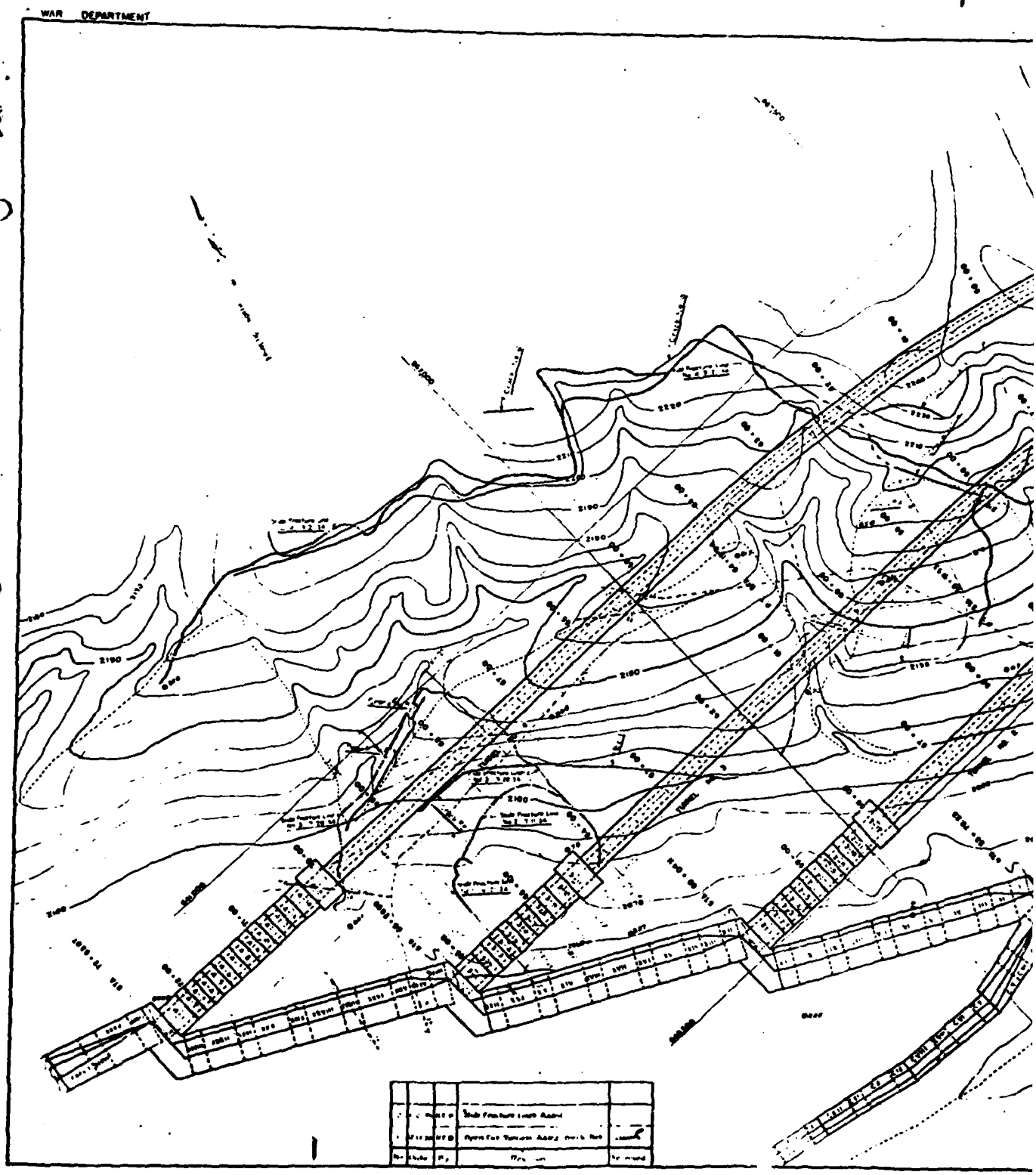
TYPICAL TUNNEL CROSS SECTION WHERE ST
ARE REQUIRED

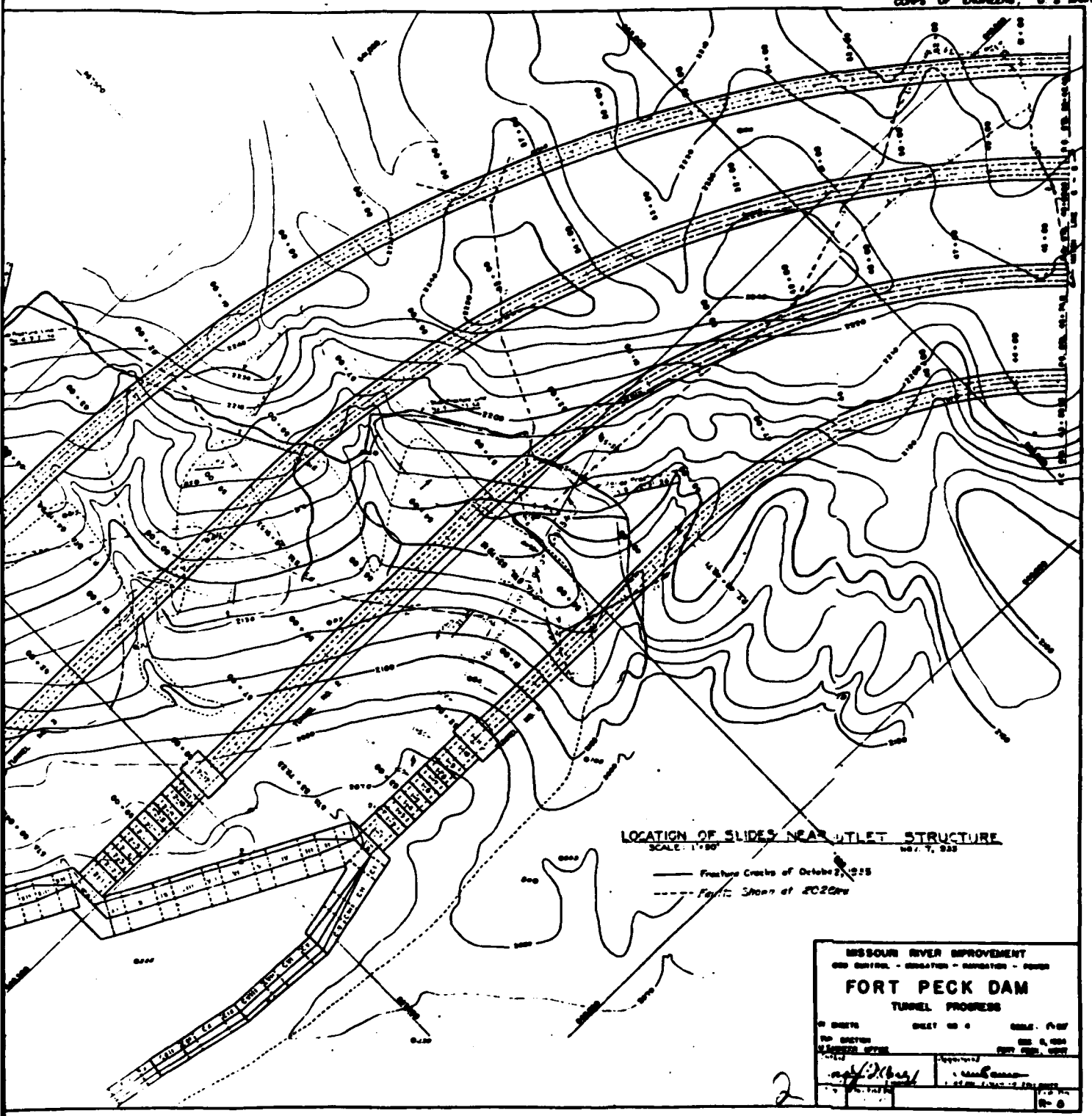


TYPICAL TUNNEL CROSS SECTION WHERE STEEL SUPPORTS ARE REQUIRED

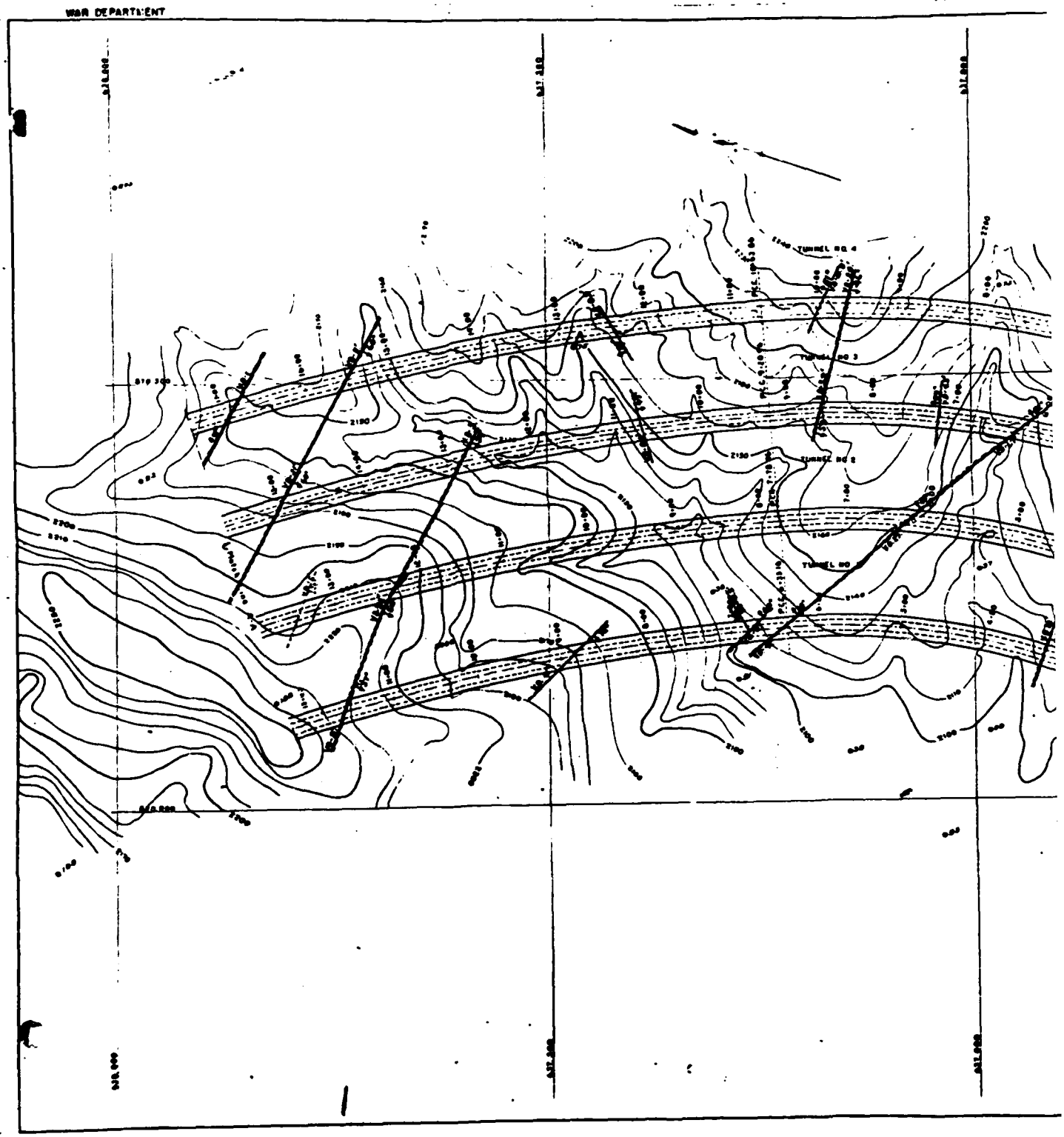
2

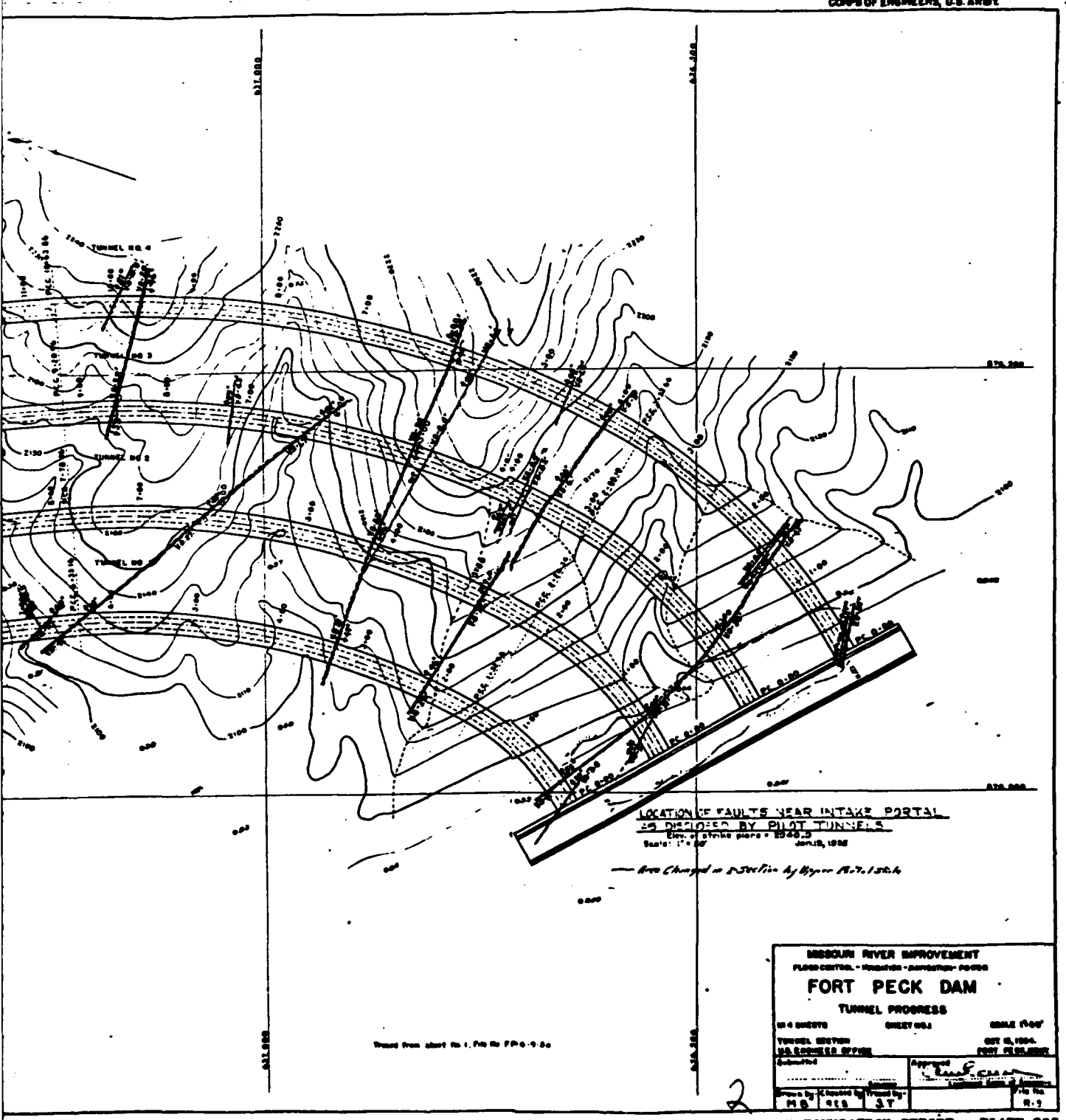
WAR DEPARTMENT




LOCATION OF SLIDES NEAR OUTLET STRUCTURE
SCALE: 1" = 50'
Fracture Cracks of October 2, 1955
Fault Shown at 2020 ft
MISSOURI RIVER IMPROVEMENT
FORT PECK DAM
TUNNEL PROGRESS

WAR DEPARTMENT





MISSOURI RIVER IMPROVEMENT

FLOOD CONTROL - IRRIGATION - NAVIGATION - POWER

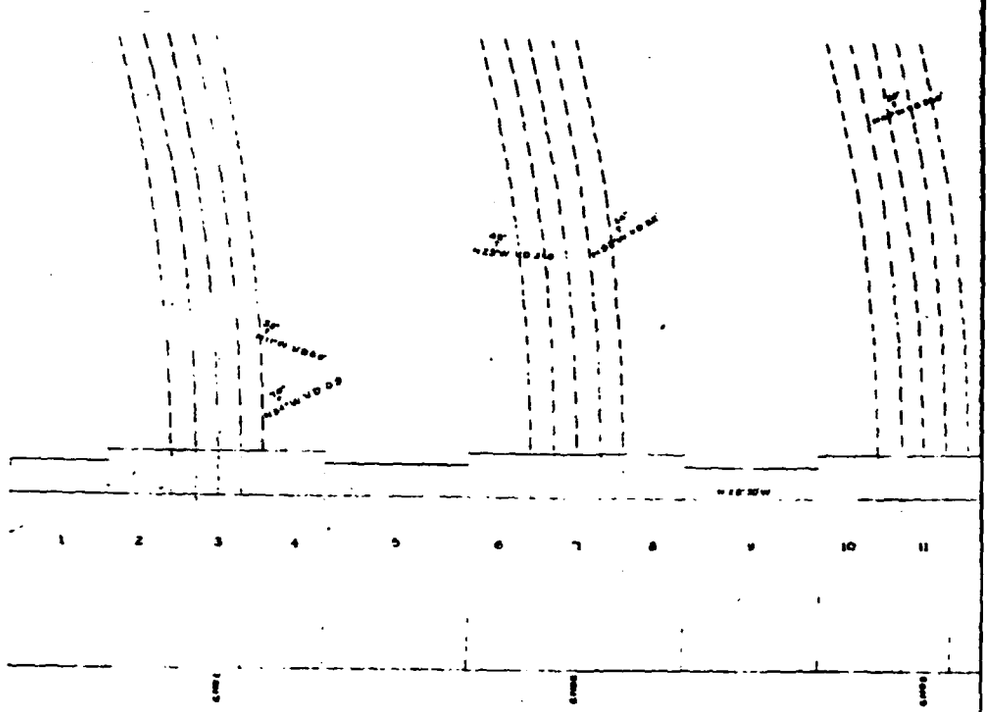
FORT PECK DAM

TUNNEL PROGRESS

12 SHEETS	SHEET NO. 1	SCALE 1" = 50'
TUNNEL SECTION		OCT. 15, 1954
U.S. ENGINEER OFFICE		FORT PECK, MONT.
Submitted		Approved
Drawn by MB	Checked by RLB	Traced by JT
		File No. R-9

2

WAR DEPARTMENT

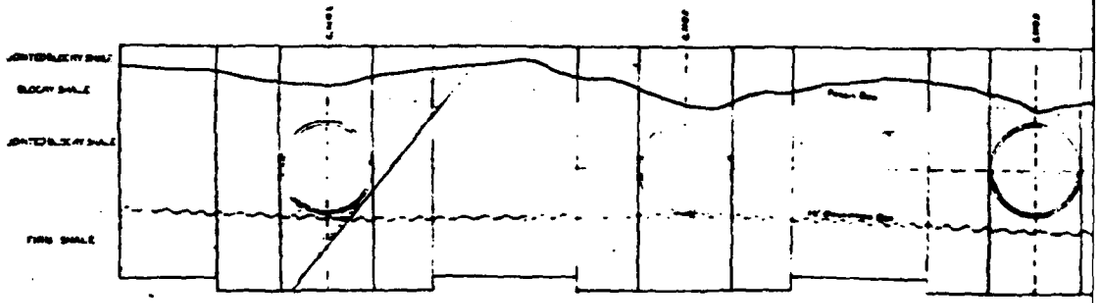


UPPER PORTALS

PLAN MAP AT ELEV 2000

SHOWING HEADWALL AND MONKEY FACTS IN TUNNELS

Scale in Feet



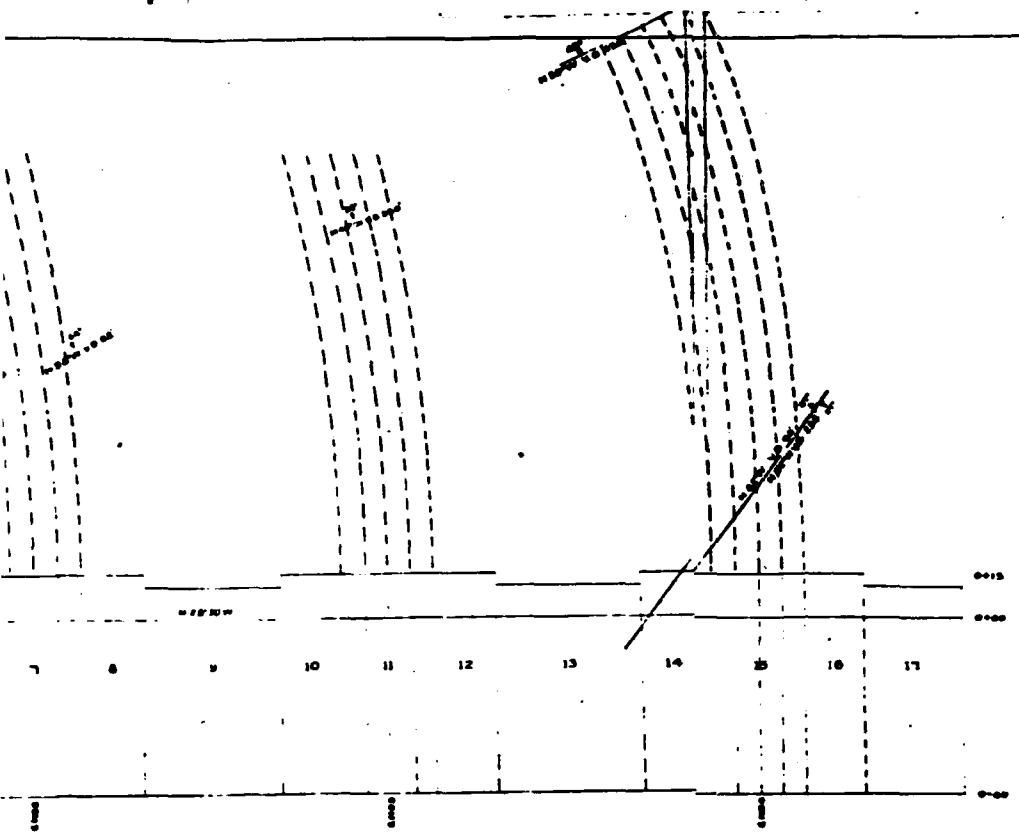
UPPER PORTALS

SECTION SHOWING GEOLOGIC STRATIGRAPHY PARALLEL TO TUNNEL

AT STA 00+10

Scale in Feet

			Grooved and Revised	
			Revision	Signature

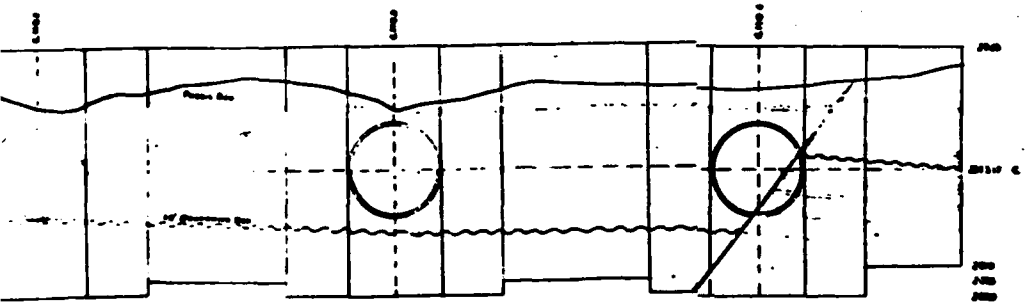


UPPER PORTALS

PLAN MAP AT ELEV 2000

SHOWING HEADWALL AND MINOR FAULTS IN TUNNELS

Scale in Feet



UPPER PORTALS

SECTION SHOWING GEOLOGIC STRUCTURE PARALLEL TO VIEW

AT STA 00+10

Scale in Feet

MISSOURI RIVER IMPROVEMENT

FLOOD CONTROL - IRRIGATION - NAVIGATION - POWER

FORT PECK DAM

UPPER PORTAL

GEOLOGIC STRUCTURE

Scale 1" = 10'

TUNNEL SECTION

U.S. ENGINEER OFFICE

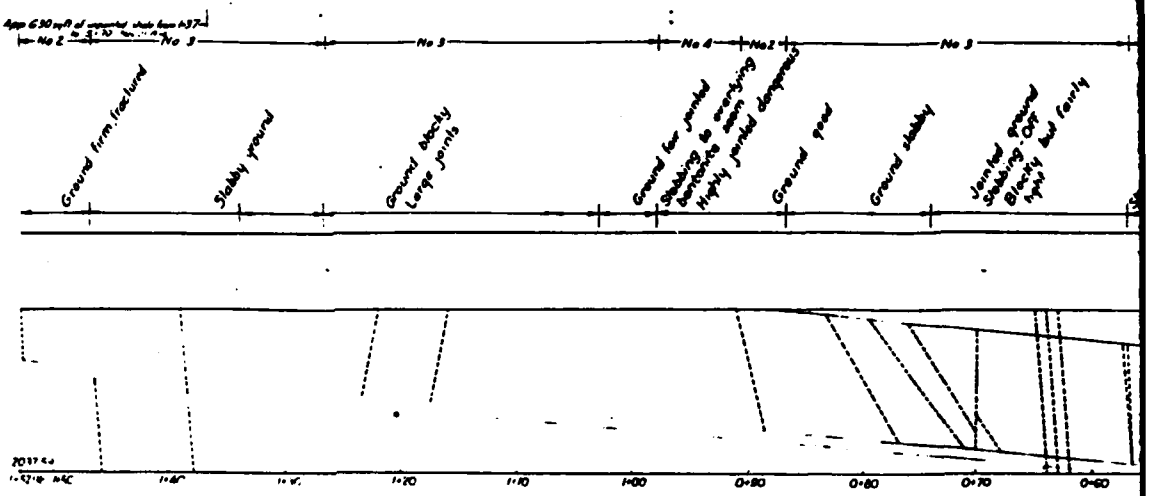
APRIL 15, 1938

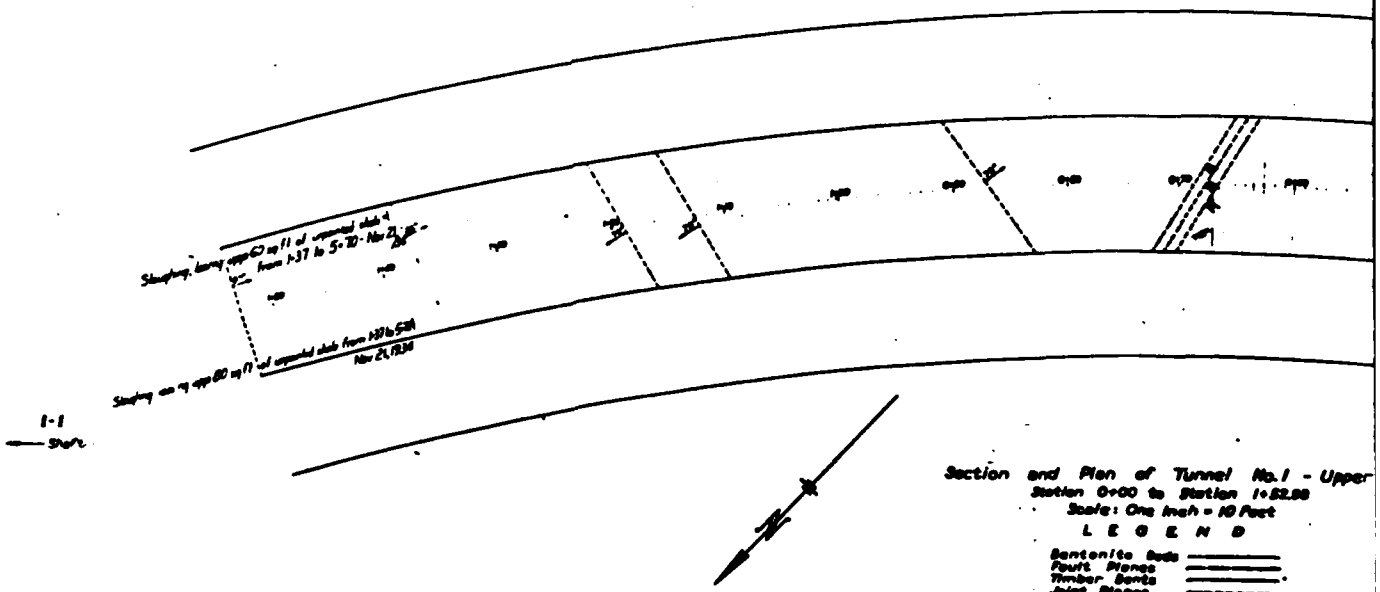
FORT PECK, MONT.

Submitted

Approved

2

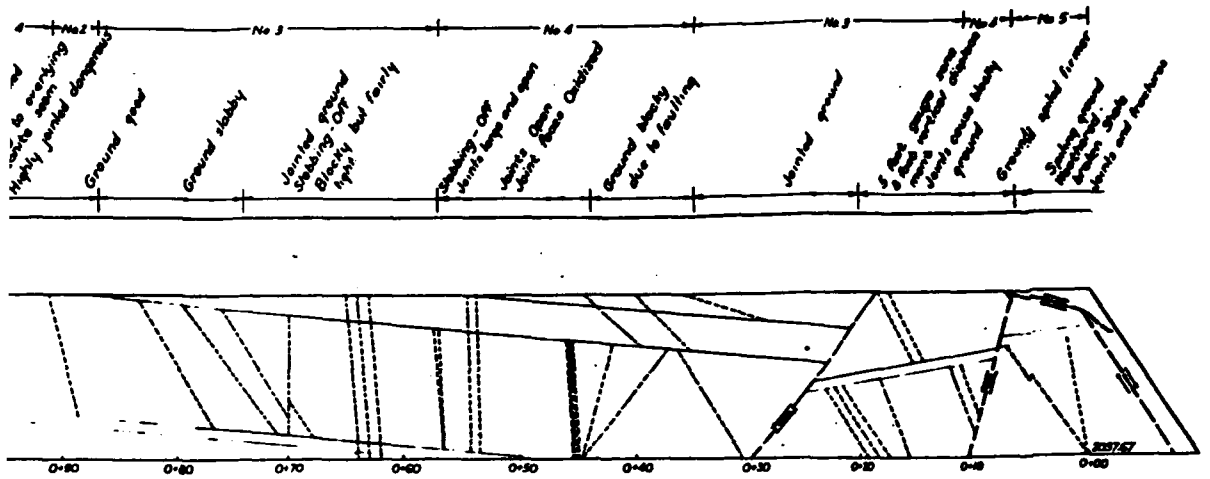


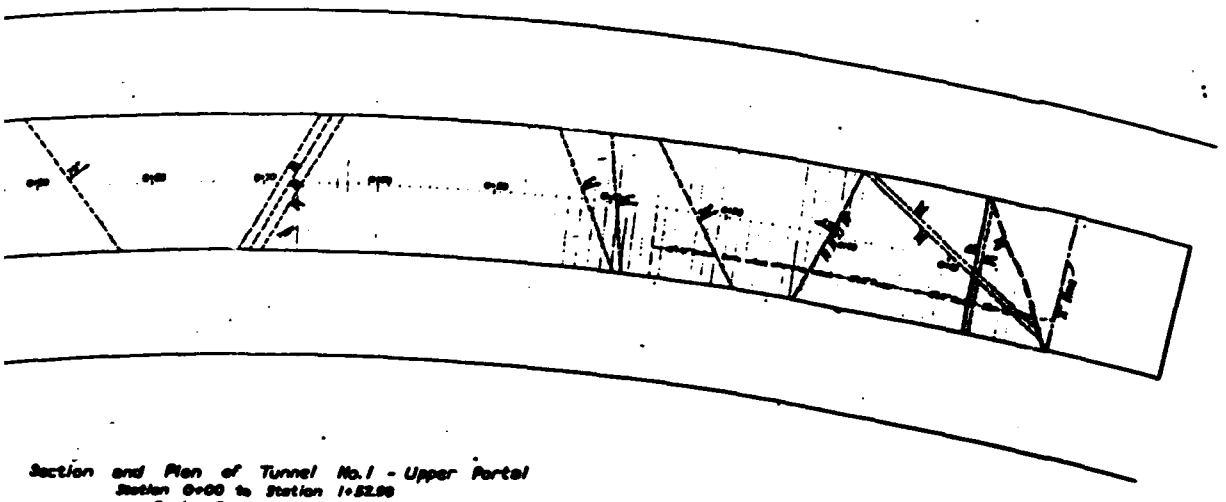


Section and Plan of Tunnel No. I - Upper
Station 0+00 to Station 1+52.88
Scale: One Inch = 10 Feet

LEGEND

Bentonite Beds
Fault Planes
Timber Bents
Joint Planes





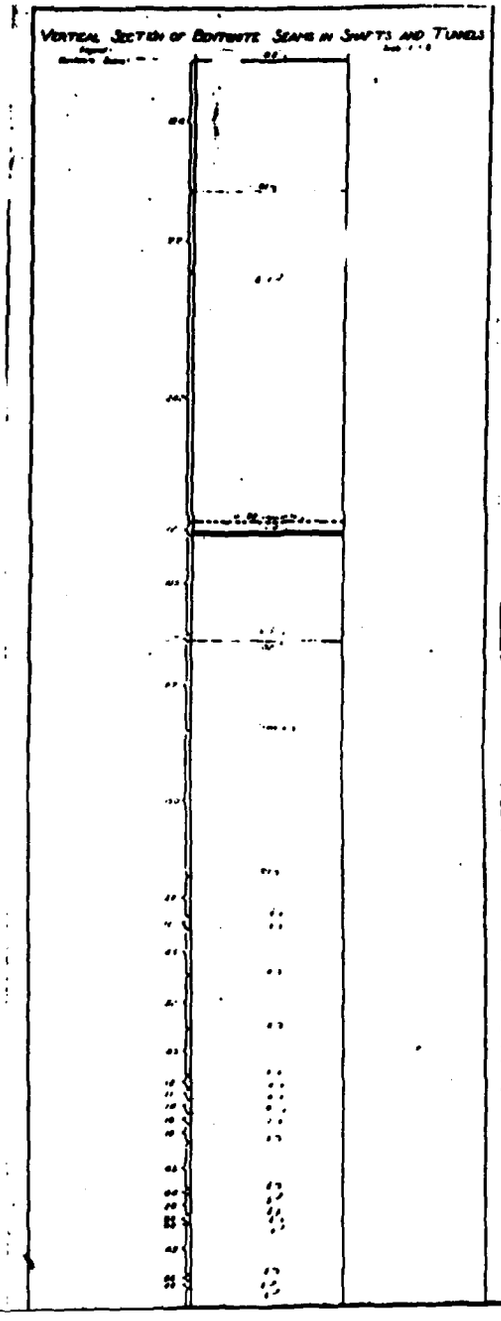
1-1
Upper Portal

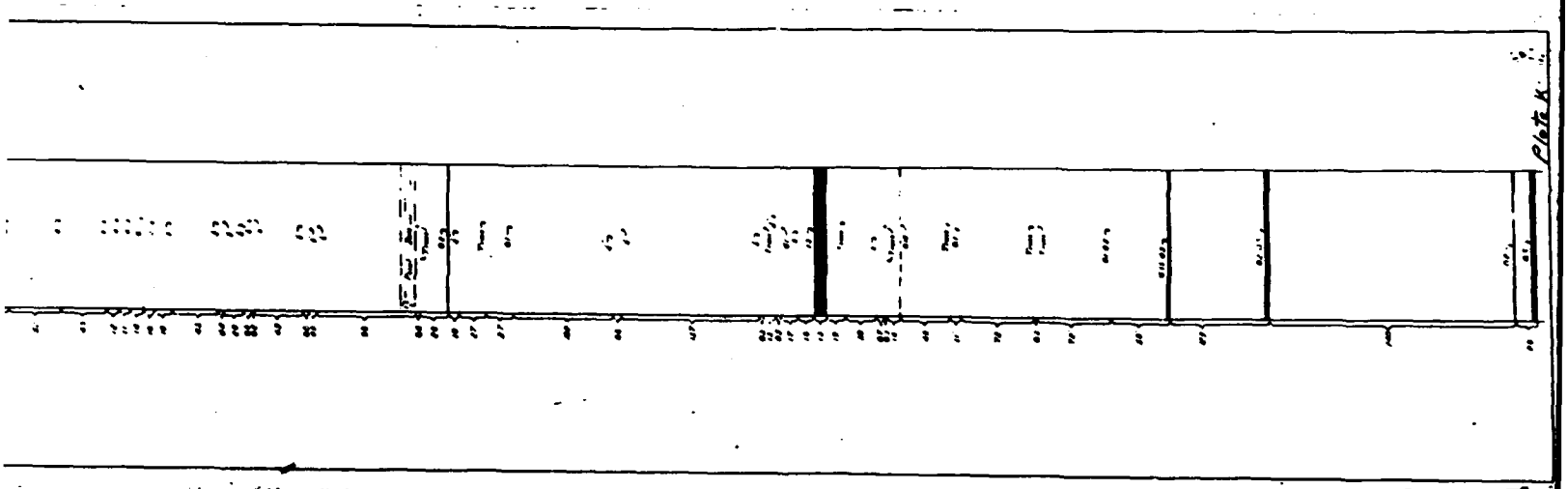
Section and Plan of Tunnel No. 1 - Upper Portal
Station 0+00 to Station 1+52.98
Scale: One Inch = 10 Feet

L E G E N D

Bentonite Beds
Fault Planes
Timber Bents
Joint Planes

2


VERTICAL SECTION OF BITUMITE SEAMS IN SHAFTS AND TUNNELS



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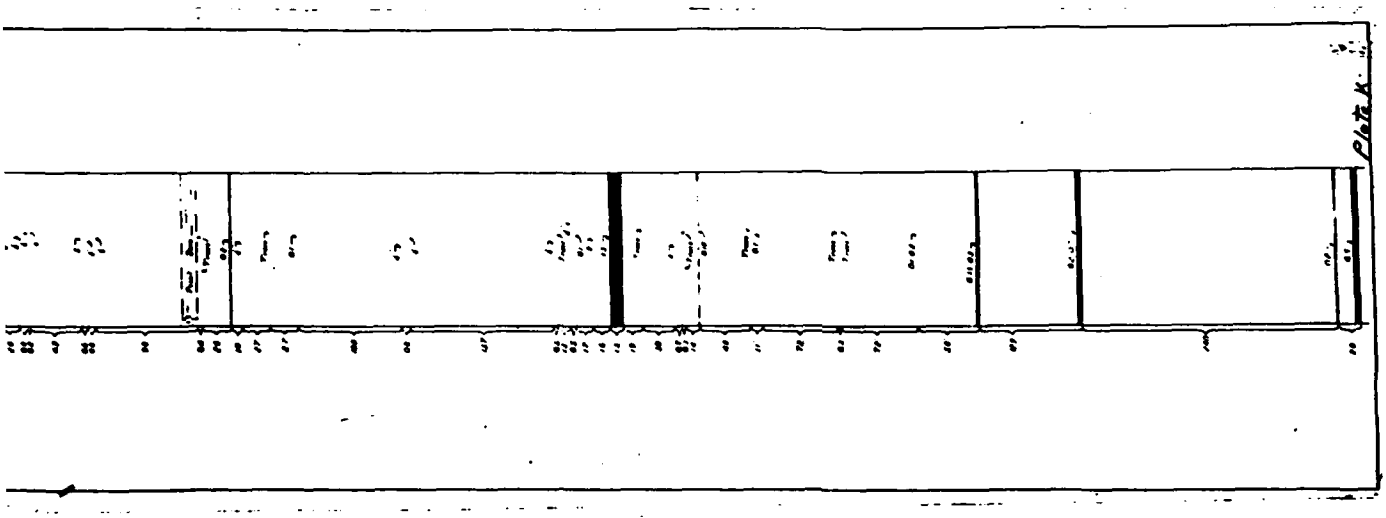
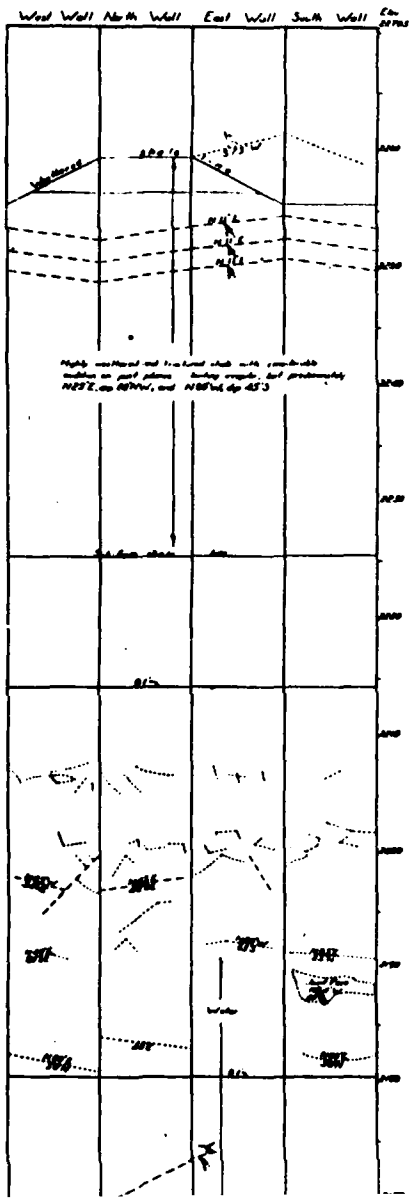


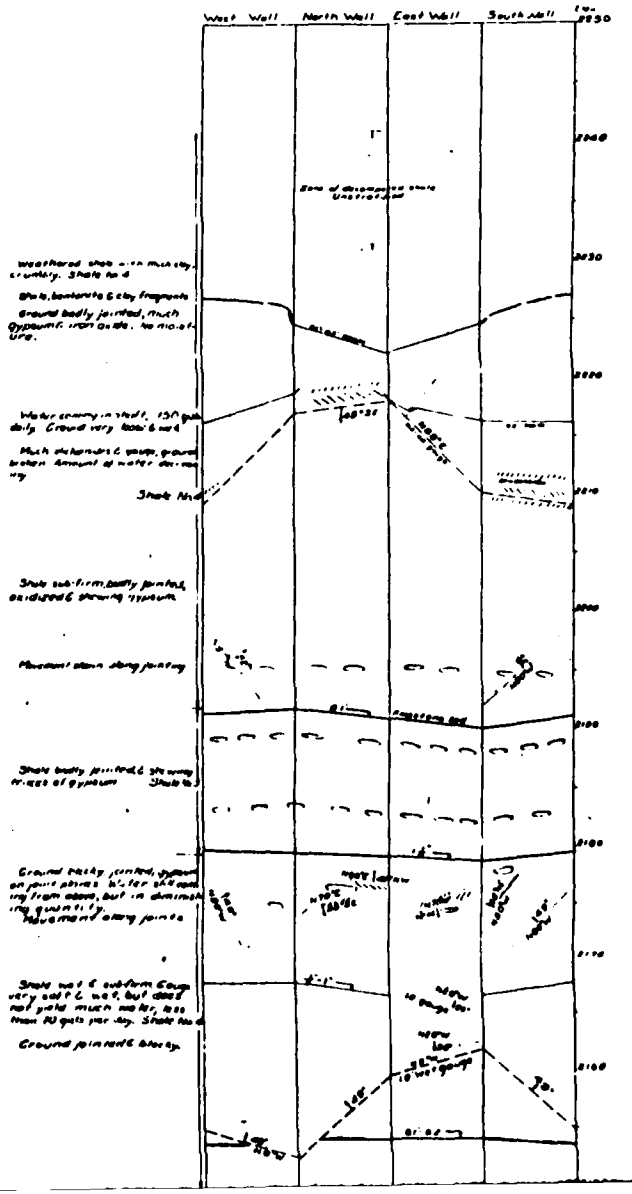
2

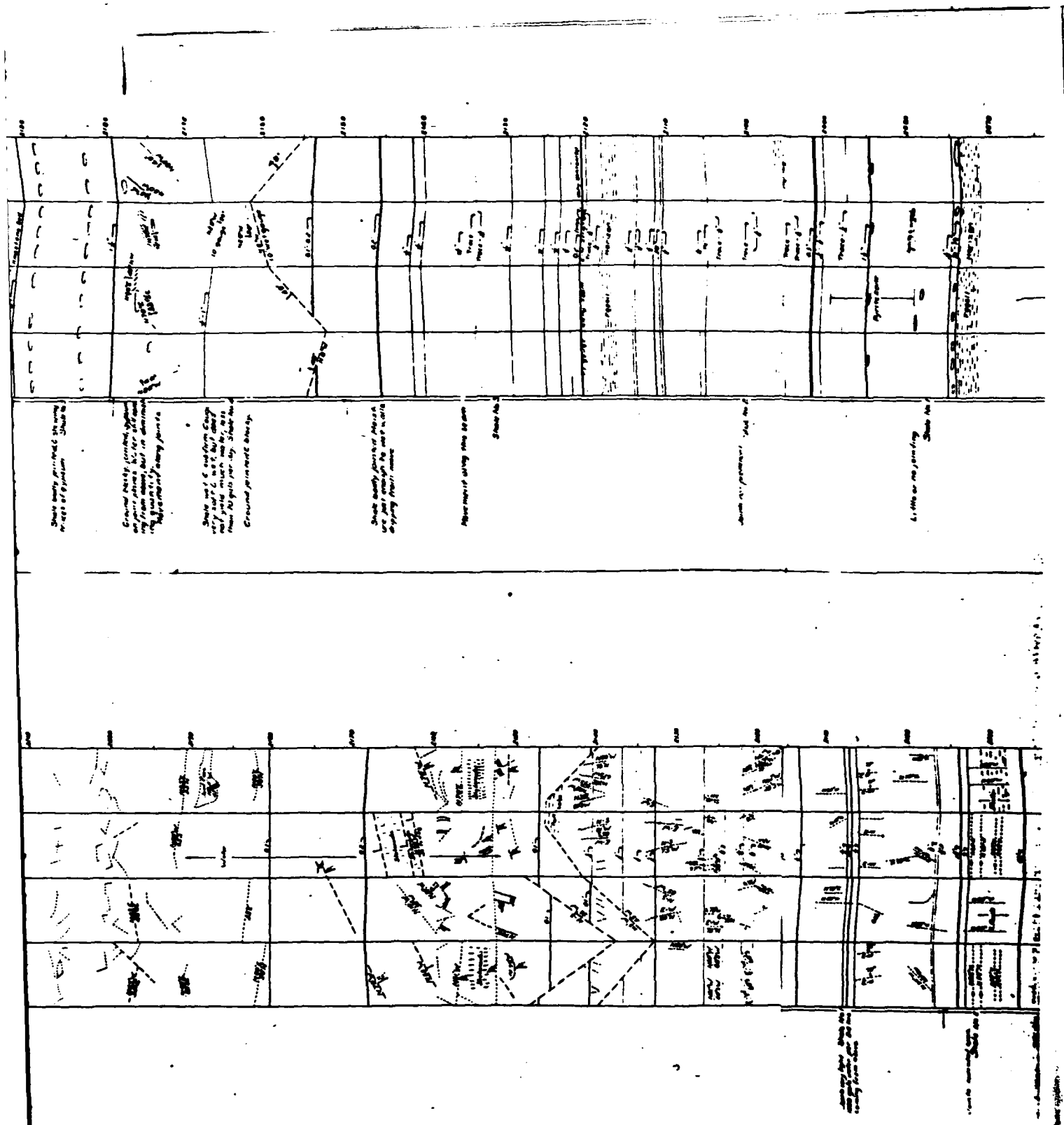
3

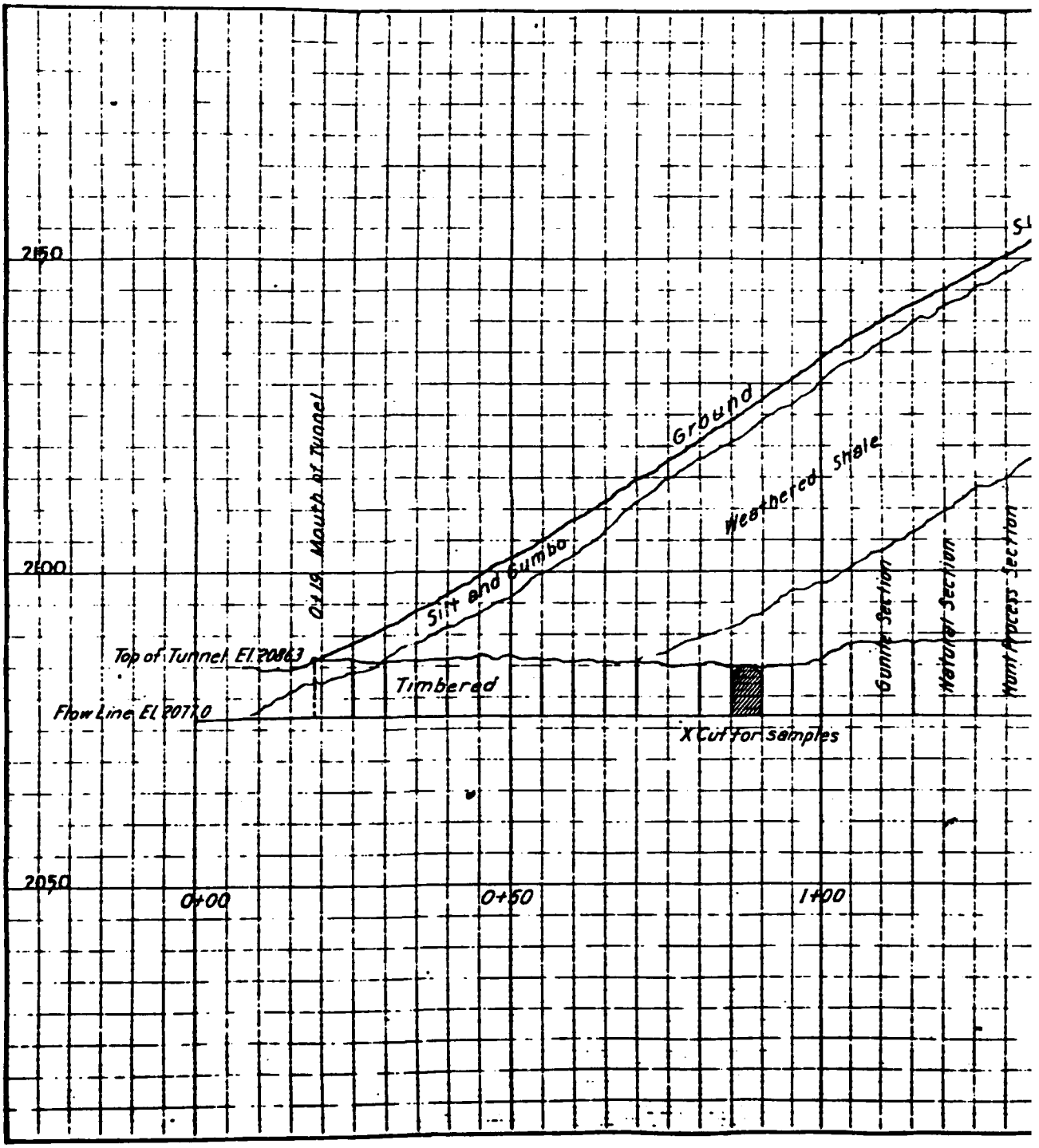
PILOT SHAFT No.2

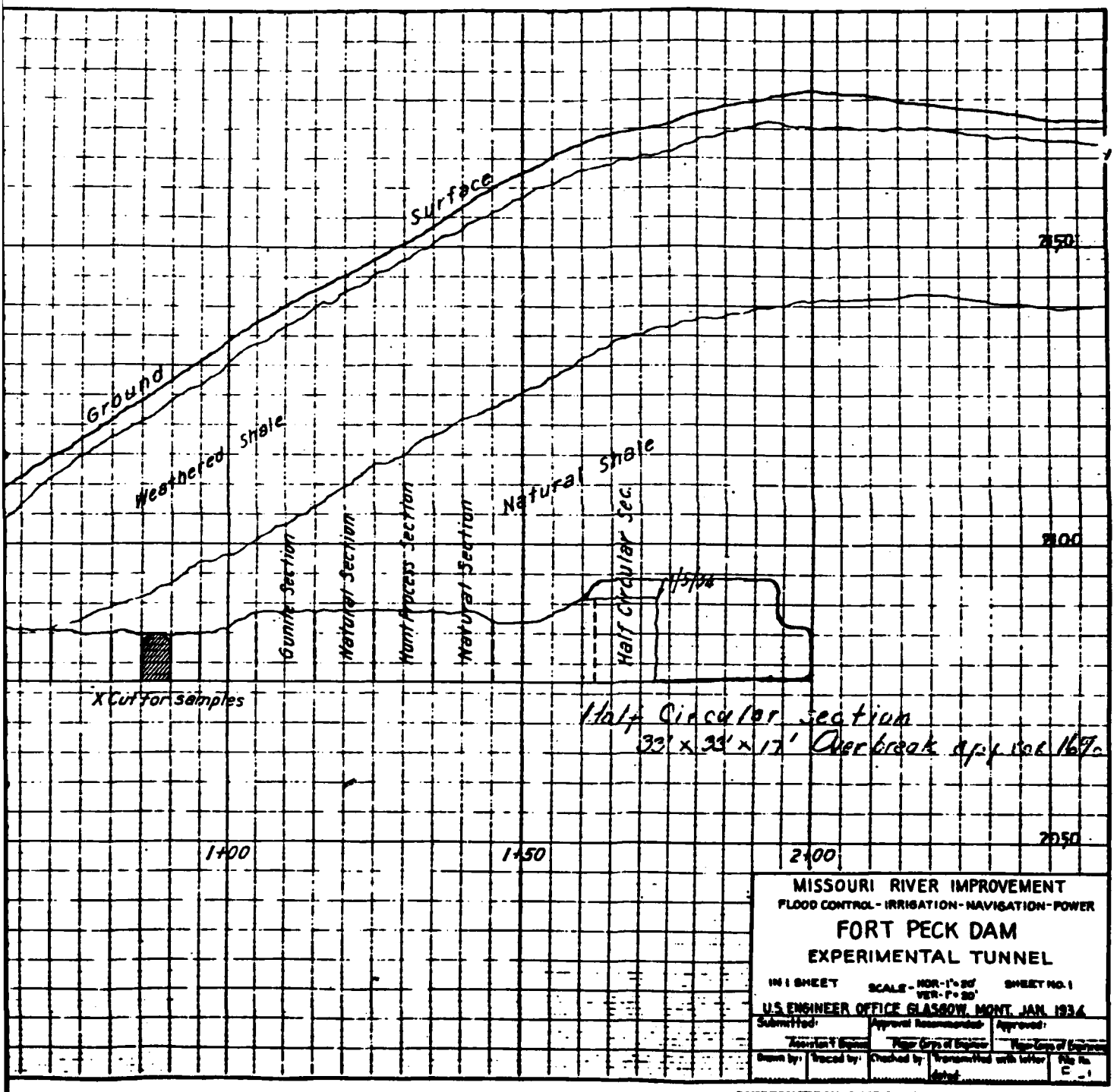


EMERGENCY CONTROL SHAFT No.2






2150
2100
2050
0+00
0+50
1+00
Ground
Weathered Shale
Silt and Gumbo
Timbered
Top of Tunnel El. 20863
Flow Line El. 2077.0
X Cut for samples
Gunite Section
Natural Section
Mount Process Section



CONSTRUCTION FOUNDATION REPORT PLATE 210

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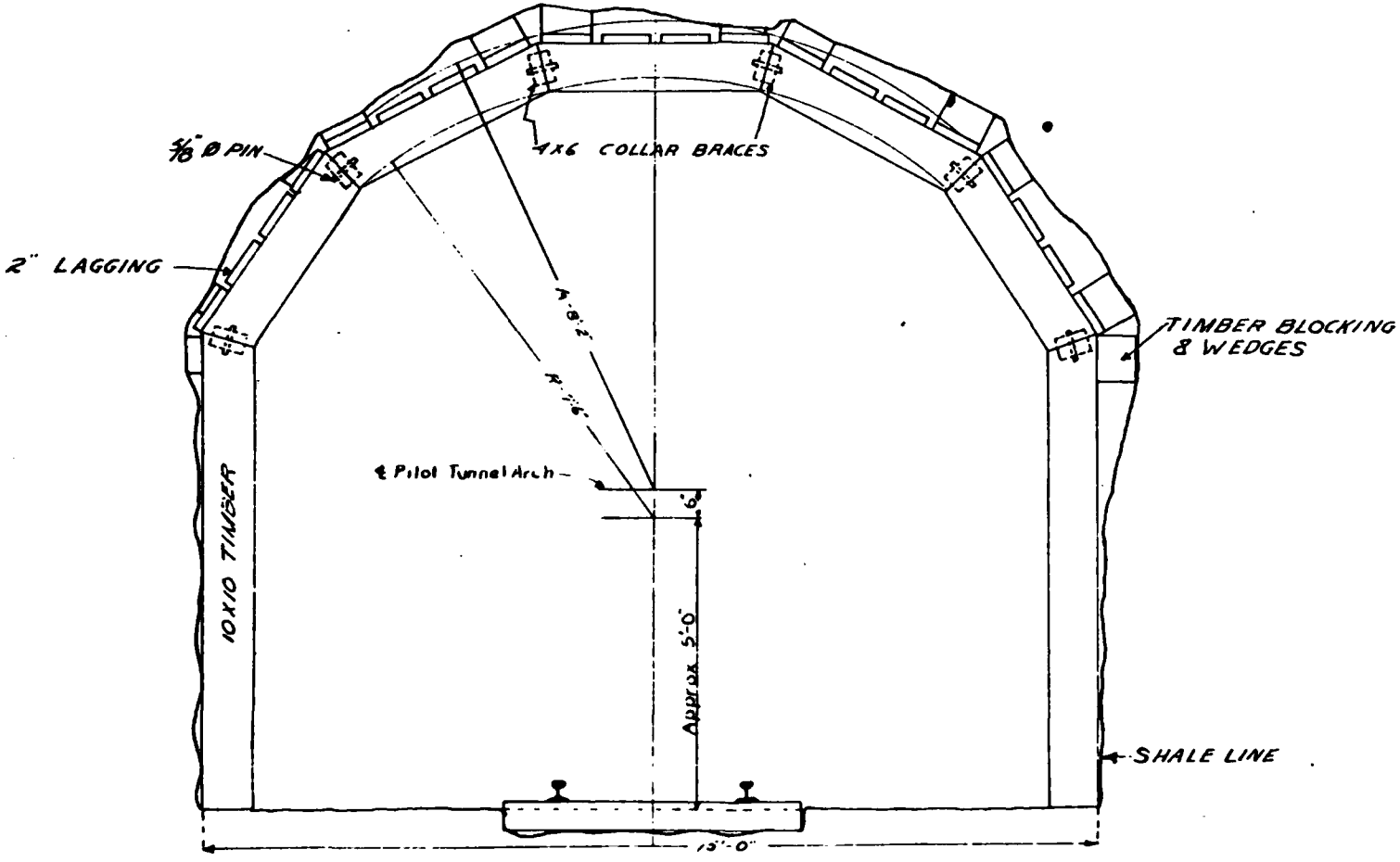

TYPICAL PILOT TUNNEL SUPPORT

END

DATE
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